

NOVEMBER 1956

RADIO - ELECTRONICS

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACH, Editor

What to Do
for
Weak Video

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Amplifier

•
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Metronome
Is Stable

•
Hi-Fi Conversions
Are Profitable

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EDITORIAL

33 Technicianless Age?—Hugo Gernsback

TEST INSTRUMENTS

34 An Electronic Scope Probe—Charles W. Rhodes
 36 Build a Dual Wide-Band Crystal Oscillator—I. Queen
 38 Tube Testers—Walter J. Swontek
 40 Calibrating AC Voltmeters—Edwin N. Kaufman

TELEVISION

41 TV Sets with Remote Control, Part III—Henry O. Maxwell
 44 Service Shop Time Savers—Stanley L. Karal
 46 Industrial TV Techniques, Part III—Edward M. Noll
 48 TV Service Clinic—Conducted by Jerry Kass
 50 Rx for Weak Video—Cyrus Glickstein

WHAT'S NEW

53 Pictorial Report of New Developments

AUDIO—HIGH FIDELITY

54 Upside-Down Amplifier—George L. Augspurger
 57 Stereo Tape Comes of Age—Herman Burstein
 60 Audio Conversions Are Profitable—Joseph Chernof

ELECTRONICS

63 Stabilizing the Metronome—Tom Jaski
 78 Confused About Transistor Types? Part II—Paul Penfield, Jr.
 81 Technical Abbreviations—Charles S. Kimball

RADIO

88 Tacan (Cover Feature)—J. Whalen
 101 Transistor Radios, Part VI—I. Queen
 104 Transistor Radio Has RF Stage—J. E. Pugh, Jr.
 108 Improving Sensitivity in AC-DC Radios—Charles Garrett

153 Books	145 People
147 Business	134 Question Box
18 Correspondence	8 Radio Month
112 Miscellany	126 Radio-Electronic Circuits
118 New Devices	150 Technical Literature
114 New Records	129 Technicians' News
131 New Tubes and Transistors	136 Technotes
140 Patents	142 Try This One

ON THE COVER

(Story on page 88)

Engineers of IT&T's Federal Telecommunication Laboratories making tests on a Tacan antenna for shipboard use, prior to shipping it to the Navy.

Color original by Dean Price

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NEXT MONTH: Stability in Feedback Amplifiers • How to Lick the Intermittent

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Edward Hahn, Illinois. Now an electronics technician with Televiso, Inc. DeVry Tech training helped him prepare for his present position.



Nick Barton, Illinois, a DTI grad, now has his own business and tells us he is "literally snowed with work."



George D. Crouch, California, was a retail store clerk. He took the DeVry Program, and today is in business for himself.

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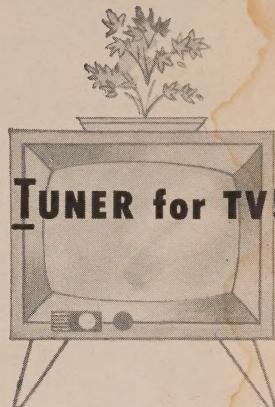


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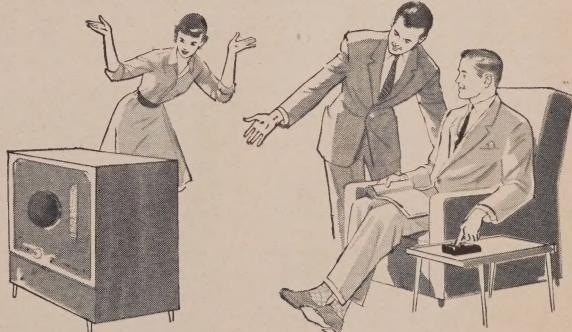
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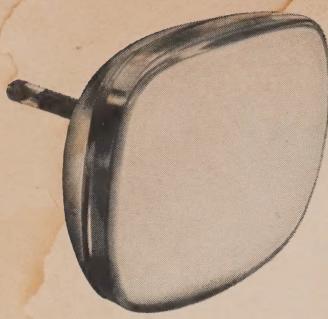
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the Radio month



MID-AIR COLLISION warning device has been developed by the Collins Radio Co. Approved by a special committee of the nation's airlines, two companies—American and United—are already negotiating to purchase the device.

The installation will be made in two stages. The initial setup will consist essentially of a horn or other audible unit and six lights. The lights will tell the pilot whether the dangerously close oncoming plane is ahead, behind, right, left, above or below. The distance will also be indicated. Readers will remember that this type of equipment was called for by Hugo Gernsback in his editorial "Airplane Collision Prevention" in the September issue. In it he said in part "... it should be possible to evolve an instrumentality whereby the pilot or navigator can read not only the exact distance between the two planes in miles, but he will see the vertical and horizontal angle of the approaching plane, too."

The final system will, in addition, provide instructions on which way to turn. A light on either the right or left side of the cockpit will indicate an abrupt turn in that direction.

The lights will be actuated by electronic computers that will consider the positions of the merging planes, relative speeds and directions of flight.

PICTURE PHONE using standard telephone line was unveiled by Bell Telephone Laboratories at a joint meeting in Los Angeles of the Institute of Radio Engineers and the West Coast Electronic Manufacturers Association. The pictures that are transmitted along

with the sound vary in size from 1 x 1½ inches to 2 x 3 inches.

This picture-phone system over ordinary telephone line was made possible by slowing down the rate of transmission of picture information so that the required bandwidth can easily be handled. The raster is made up of 60 lines, each of which may have a maximum of 40 dots.

Thus, each complete frame may be considered to contain 2,400 dots. If a single frame were transmitted each second, an overall bandwidth of 1,200 cycles would be necessary. With this system one complete frame is transmitted every 2 seconds, requiring a bandwidth of only 600 cycles.

Since the 600-cycle video band contains very-low-frequency components which might be greatly attenuated during transmission over phone lines, a carrier scheme is used in which the video signal amplitude modulates a 1,200-cycle carrier. The transmitted signal is then a conventional AM double-sideband signal with a frequency range of 600 to 1,800 cycles, an optimum range for telephone-line transmission.

The picture equipment is still undergoing development and is not ready for manufacture or commercial use.

FIRST TRANSLATOR GRANTS have been made by the Federal Communications Commission. In authorizing the "inexpensive" translator stations the FCC stated that this "is part of the commission's program for bringing TV service to small communities."

The grants were made to the Mount



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(Continued)

RADIO MONTH

Grant Television Booster Service Corp., Hawthorne, Nev., to rebroadcast channel 4, KRON-TV, San Francisco, on channel 70, and to James R. Oliver, Bishop, Calif., to rebroadcast the Los Angeles signals of channel 2, KNXT, on channel 70, and channel 4, KRCA, on channel 73.

ELECTROCUTIONS caused by improper television antenna installations have prompted several North Carolina cities to consider adopting ordinances regulating these installations. While one city, Durham, has dismissed the idea as being impractical, another, Greensboro, has begun checking all sets in the city to see if they are grounded correctly.

Representative of the type of accidents occurring during antenna installations by untrained persons is a recent report from New Port Richey, Fla. A 61-year-old woman, Mrs. Aurelia M. Walrath, was killed instantly when the guy wire from a television antenna fouled a 7,200-volt high-tension wire while she was helping her husband install a TV antenna.

Calendar of Events

1956 High-Fidelity Show and Music Festival, Nov. 2-5, Palmer House, Chicago. RADIO-ELECTRONICS will exhibit in Room 746.

New England Radio Electronics Meeting, Nov. 15-16, Hotel Bradford, Boston.

Dallas High-Fidelity Music Show, Nov. 16-18, Hotel Adolphus, Dallas, Tex.

St. Louis High-Fidelity Music Show, Nov. 23-25, Hotel Statler, Saint Louis, Mo.

Electronics Fair of Long Island, Dec. 6-8, New York State University, Farmingdale, N. Y.

1956 Eastern Joint Computer Conference, Dec. 10-12, Hotel New Yorker, New York City.

RETMA Symposium on Applied Reliability, Dec. 19-20, Board Hall, University of Southern California, Los Angeles, Calif.

TELESCOPE BOOSTER now being developed promises to provide a tenfold increase in the power of the world's biggest telescope on Mount Palomar. The booster, known as an image converter, consists of a vacuum tube containing a photocathode which emits electrons when exposed to starlight. The electrons are focused and passed through an opening only a few millionths of an inch thick. A photographic plate is directly behind the opening.

The efficiency of the image converter is due to the ability of light to more effectively produce electron flow from a photocathode than to create an image on a photographic plate. The image converter is placed at the focal point of the telescope and is expected to furnish pictures of stars 10 times fainter than can now be seen with the 200-inch telescope. It will also make modest telescopes the world over equal to the present power of Mount Palomar.

SOVIET TV BOOM finds large cities like Moscow and Leningrad with roofs crammed with television antennas, reports the European news director of Fairchild Publications, who was recently permitted to visit Russia. Start-(Continued on page 14)

Look What **RADIO-ELECTRONICS** has
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By Cyrus Glickstein

THE NEW MOTION-PICTURE SOUND

By Aaron Nadell

AUDIO TRANSFORMERS

By Norman H. Crowhurst

A SELF-CALIBRATING MARKER GENERATOR

By Richard Graham

SIMPLE TRANSISTOR SHORTWAVE RECEIVER

By Joseph Braunbeck

IMPROVING SOUND IN AM RADIOS

By Albert Stratmoen

A HOME INTERCOM SYSTEM

By John F. Millar

SELLING EXTRA TELEVISION SERVICE

By Matthew Mandl

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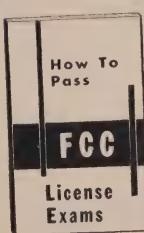
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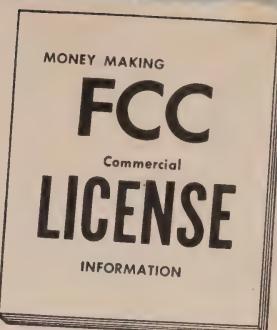
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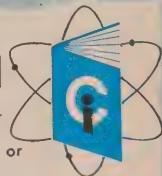
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Boyd Daugherty, Falls Church, Va.

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TECH-MASTER TM-15A Ultra-Linear Williamson-Type 20-Watt Power Amplifier Kit

Flat response throughout the audible frequency range as well as considerably below and above it. Vanishingly low distortion at all normal listening levels. Not more than 1/2% intermodulation or harmonic distortion even at 15 watts output. Smooth, crisp, transparent listening quality. Superior transient response. Hum and noise level 70 db below rated output. 1.1 volts RMS input required for 20 watts output. Speci ally wound high-fidelity output transformer with 4, 8 and 16 ohm output impedances. Comes with sockets, terminal strips and connectors already mounted.

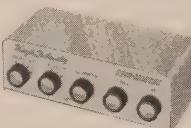
Model TM-15A (dimensions 9" x 12" x 6½"; weight 27 lbs.) \$49.95



TECH-MASTER TM-16A De Luxe, Self-Powered Preamplifier-Equalizer Kit

Completely redesigned according to the latest techniques. Contains the most advanced features: 3-position phono equalizer (78 rpm, old 78's, RIAA, AES). Four input channels (one low-level, high-gain input for magnetic cartridges; three high-level; high-impedance inputs for AM, FM, or TV tuner, crystal or ceramic cartridge, high-output microphone, tape recorder, etc.). Loudness compensating control. Bass and treble controls with 15 db boost or cut at 20 cps and 20 kc, respectively. Cathode follower output. Smartly styled in handsome lacquered cabinet. Comes with sockets, terminal strips and connectors already mounted. Amazingly simple to assemble for trouble-free high-fidelity results.

Model TM-16SP (dimensions 9 7/8" x 3 3/8" x 4 1/2"; weight 4 lbs.) \$24.50
Matching gold escutcheon 1.50



TECH-MASTER TM-17P Economy Preamplifier-Equalizer Kit

Same basic design as the Model TM-16SP, except for 3-position phono equalizer (78 rpm, RIAA, AES), standard true-taper volume control and provision to obtain power from the main amplifier or a similar external power supply (120 volts DC @ 6 ma, 6.3 volts AC @ 600 ma). Plug-in connection for TM-15A furnished. Cathode follower output. Gold-tone cabinet. Comes with sockets, terminal strips and connectors already mounted.

Model TM-16SP (dimensions 9 7/8" x 3 3/8" x 4 1/2"; weight 4 lbs.) \$19.95



TECH-MASTER FM-18 Hi-Fi FM Tuner Kit

Designed for optimum reception and sound quality at minimum cost. Sensitivity 4 microvolts for 20 db quieting. IF bandwidth 200 kc. Drift-free ratio detector. Automatic frequency control (AFC) with manual front-panel cutoff. Micro-vernier tuning. Both cathode follower and high-impedance outputs provided. Self-contained power supply. Very easy to assemble.

Model FM-18 (dimensions 4 1/2" x 8" x 6 1/4"; weight 6 1/2 lbs.) \$29.95
Model 18-C Cabinet 7.50



1 TECH-MASTER amplifier, preamplifier, tuner and radio kits represent the ultimate in modern electronic kit design—nothing is easier or more fool-proof to assemble; nothing gives finer performance once assembled!

2 TECH-MASTER hi-fi kits carry the double guarantee of the Tech-Master Corporation, famous leaders in custom television and high fidelity since 1942, and of the LOCAL electronic parts distributor who fills your order and acts as your convenient, near-by source of expert information and advice. Ask him to demonstrate a Tech-Master kit when you are in his neighborhood—consult him again if you should ever need technical assistance, testing or service after you have purchased your kit!

3 TECH-MASTER hi-fi kits now offer you the unique convenience of simplified mail order from a LOCAL firm combined with the extra courtesy and sales backing you expect when dealing with a reliable parts-distributor.

ORDER NOW FROM YOUR NEAREST TECH-MASTER DISTRIBUTOR:

California, Pasadena
Dow Radio Inc.
1759 E. Colorado St.

California, San Francisco
Market Radio Supply Co.
1240 Market St.

Colorado, Denver
Fistell's Radio & Electrical Supply Co.
1081 Lincoln Street

Florida, Miami
East Coast Radio & Television Co.
1900 N.W. Miami Court

Georgia, Atlanta
Specialty Distributing Co., Inc.
425 Peachtree St. N.E.

Illinois, Chicago
J. G. Bowman and Co.
513 E. 75th Street

Indiana, South Bend
Radio Distributing Co.
432 S. Carroll St.

Maryland, Baltimore
Radio Electric Service Co.
5 North Howard Street

Massachusetts, Cambridge
Hi-Fi Lab Electronic Supply
1077 Massachusetts Ave.

Minnesota, St. Paul
Gomer Electronics Co.
370 Minnesota St.

Missouri, St. Louis
Walter Ashe Radio Co.
1125 Pine St.

New Jersey, Newark
Radio Wire Television Inc.
24 Central Ave.

New York, New York
Airex Radio Corp.
64 Cortlandt St.
Federated Purchaser Inc.
66 Dey St.

Ohio, Dayton
Stotts-Friedman Co.
135 E. Second Street

Pennsylvania, Philadelphia
Albert Steinberg and Co.
2520 N. Broad St.

Texas, Houston
Gulf Coast Electronics
1110 Winburn St.

Washington, Seattle
Seattle Radio Supply Inc.
2117 Second Ave.

West Virginia, Wheeling
James M. Black and Sons
952 Market St.

Canada, Montreal
Payette Radio Ltd.
730 St. James St., West

TECH-MASTER CORPORATION



75 Front Street, Brooklyn 1, New York

RADIO-ELECTRONICS

another Raytheon

FIRST



Thanks to an exclusive new Raytheon fin design, the Raytheon 6DQ6 is the first TV tube which eliminates SNIVETS that is 100% interchangeable — will work without special selection. It eliminates borderline performance, too, because its new design gives it additional and improved sweep characteristics not available in ordinary types.

Raytheon 6DQ6 tubes provide SNIVET free performance because they are individually tested for deflection operation and are given special tests under sweep amplifier conditions. Raytheon 12DQ6 and 17DQ6 Tubes incorporate this same fin construction and will provide the same superior, trouble-free performance.

An added bonus from the Raytheon 6DQ6 is that its interchangeability simplifies stocking. (It's an improved replacement for 6CU6 and 6BQ6GA series.)

Finally, the Raytheon 6DQ6 is another outstanding example of how Raytheon's superior engineering skill and production know-how have brought you still another tube that is first and finest in the field.

* SNIVET — a vertical disturbance on the right hand area of the screen.



RAYTHEON MANUFACTURING COMPANY

Receiving and Cathode Ray Tube Operations

Newton, Mass. • Chicago, Ill. • Atlanta, Ga. • Los Angeles, Calif.

Raytheon makes all these

Receiving and Picture Tubes, Reliable Subminiature and Miniature Tubes, Semiconductor Diodes and Transistors, Nucleonic Tubes, Microwave Tubes.

Excellence in Electronics

**New Styling...
New Features...
A Completely New Line
from H. H. Scott**



210E

**3 NEW FEATURE-
PACKED AMPLIFIERS!**

(Models 90C, 210E complete amplifiers, 121C preamplifier) Color-marked Green Dot controls that make it easy for your family to operate your hi fi system . . . smartly designed mahogany cabinets . . . years ahead features that defy obsolescence . . . that's H. H. Scott for '57, your best dollar investment. See for yourself!

4 NEW SUPER-SENSITIVE TUNERS!

(Models 330B, 331B AM-FM tuners; 311B, 310B FM tuners) For the first time AM that gives you audio response beyond 10 kc . . . FM with new wide-band circuitry that makes drift a thing of the past . . . AM-FM tuners equipped for Stereophonic (binaural) operation. That's H. H. Scott for '57. Hear for yourself!



330B

**2 COMPLETELY REDESIGNED
POWER AMPLIFIERS!**

(Models 240, 280) Exclusive Dynamic Power Monitor on Model 280 affords full output on music, yet protects expensive speakers against burnout . . . variable damping controls for perfect speaker matching . . . new exterior styling . . . clean distortion-free performance typical of all H. H. Scott components. Judge for yourself!



280

ALSO SEE THE NEW 710A TURNTABLE

**Visit your dealer or write today
for complete technical specs.**

H. H. Scott Inc.
385 Putnam Ave.
Cambridge, Mass.

**k.h.
Scott**

Please rush me your new catalog E-11 and complete
technical specifications on H. H. Scott components for '57.
Name _____
Address _____
City _____
State _____

RADIO MONTH

(Continued)

(Continued from page 10)

ing virtually from scratch in 1953, at the end of 1955 there were 1 million TV sets in operation in Russia. By the end of 1956 this total will be doubled. This year most sets produced were 12- and 14-inch models, with the trend toward 14- and 17-inch units.

At the end of 1955 there were 15 state stations; by the end of this year there will be 20. In addition, there are some 60 local stations.

AIR TRAFFIC CONGESTION is to be alleviated by the use of closed-circuit TV in air traffic control. Using New York City as the test area, the Civil Aeronautics Administration announced that an experimental setup is in operation at the New York International Airport, Idlewild.

The heart of the system is a long-range radar and television arrangement in which the radar aids the control center to track planes into the New York area with blips on the radar screens. The television section relays the control center's radar images to the towers at individual airports nearby to help the planes land.

FOUR NEW TV STATIONS have gone on the air since our last report:

KAVE-TV	Carlsbad, N.M.	6
KFXJ-TV	Montrose, Colo.	10
KILT	El Paso, Tex.	13
WTWV	Evansville, Ind.	7

One station has left the air:

WHUM-TV	Reading, Pa.	61
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This is the 62nd uhf station to close.

Station CBLT, Toronto, Canada, has changed channels, from 9 to 6.

The total of TV stations now operating in the U.S. and its territories is 486 (391 vhf, 95 uhf), including 22 noncommercial of which 5 are uhf ones.

FIRST PHONE CABLE across the Atlantic was put into operation this fall. Operated by AT&T, the new cable will carry 36 conversations simultaneously, free from interference which occasionally hampered the trans-Atlantic radiotelephone.

ELECTRONIC TRAILMAKER is being used by the Army to indicate a safe trail on the Greenland ice cap. Poor visibility during the polar night, snowstorms and summer "white-outs" (dense Arctic fog) make free movement over the ice cap virtually impossible. Safe trails through this area are crooked and narrow and visual markers like flags and poles are obscured by poor visibility or destroyed by the elements.

The electronic trailmarker consists of two parallel wires buried beneath the snow on either side of the trail. Alternating current is fed into the wires and a receiver mounted on a tracked vehicle detects the current in the wires. Indicators in the vehicle give the driver his position within the trail. Warning devices inform the driver when the vehicle gets out of bounds and crosses a trail wire. END

Free!

to Service Technicians Only

THE NEW SAMS INDEX TO PHOTOFAC T FOLDERS

**it keeps you up-to-the-minute
on receiver coverage**

PHOTOFAC T Folders give you the world's finest Service data on TV and radio models just as soon as they hit the market. Now—with the new INDEX SYSTEM to PHOTOFAC T, you locate the latest PHOTOFAC T coverage immediately.

If you're a Service Technician, you can get the new Sams Index FREE. Here's how it keeps you up-to-date on receiver coverage: The Master Index (36 pages—issued twice yearly) is the complete reference to all PHOTOFAC T Folders produced up to the date of its issue. In addition, you get an Index Supplement each month covering that month's releases of PHOTOFAC T Folders. Thus, the Master Index plus the supplements keep you right up with current PHOTOFAC T coverage. (The Index Supplements also appear each month in "PF Reporter" Magazine.)

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TECHNICIANS

Send me your FREE Master Index to PHOTOFAC T Folders (twice yearly), and put me on your mailing list to receive all Index Supplements. My letterhead and/or business card is attached.

I am a Service Technician: full time; part time.

My Distributor is: _____

Shop Name: _____

Attn: _____

Address: _____

City: _____ Zone: _____ State: _____

**TAKE THE RIGHT STEP TO TIME-SAVING
PROFIT-BUILDING BUSINESS: Sign up with
your Parts Distributor to get PHOTOFAC T
Folder Sets automatically each month.**

DO IT NOW!

TEST 5 TUBES in 4 SECONDS EACH...ACCURATELY!

WITH THE NEW ADVANCED ENGINEERED

precise MODEL 116

Gm. & Em. ULTRAFAST TUBE & TRANSISTOR TESTER

PRECISE MODEL 116K in kit form.....\$69.95

PRECISE MODEL 116W factory wired.....\$119.95
Incl. carrying case and cover



Servicemen know the Precise Model 111 (the winner in an independent survey) easily rates "the finest tube tester in the field" at any price, BUT FOR AN ON THE JOB QUICK-TEST . . . the fastest, most accurate is the PRECISE Model 116. What's more you test tubes the foolproof method inherent in the famous Precise Model 111.

Did you ever wish you could plug in 5 of the same type tubes at once and check each one individually by rotating a switch? YOU CAN WITH THE PRECISE MODEL 116—Plug in 5 IF tubes and let them heat up at once and then check each one separately by rotating the TUBE BANK switch. ACTUALLY CHECK 5 TUBES IN 20 SECONDS, 4 SECONDS PER TUBE.

The Precise Model 111 taught the lesson that IF amplifier tubes (like the 6BC5 or 6AU6) should be tested for Gm (mutual transconductance) while the power amplifiers (like the 6L6) should be tested for Em (emission)—that's ULTRAFAST Model 116 test! It checks each section of each tube separately . . . by rotating the FUNCTION SWITCH . . . each triode of a dual triode is checked individually . . . each diode and the triode of a duo-diode-triode is separately tested and not lumped as in other testers . . . and a pentode is tested as a pentode—not a diode. TRANSISTORS, SHORTS, GAS, LIFE, Em, Gm etcetera can be tested with the PRECISE Model 116.

You can inexpensively extend the Precise Model 116 to test filament current, etc. The Model 116 gives an accurate, ultra-fast (3 basic knobs for testing) check of television tubes!

No Surplus—An etched panel—beautiful Moleskin covered wood carrying case and cover and specially simplified instructions makes the PRECISE MODEL 116 THE FINEST FAST-CHECK TUBE TESTER AND DOLLAR EARNING TRAVELING COMPANION A TV SERVICEMAN EVER HAD.

Not yet at your distributor. Order NOW to insure early delivery.

SEE YOUR LOCAL DISTRIBUTOR FOR PROOF OF WHAT WE OFFER — OR WRITE US FOR DOCUMENTARY RESULTS OF AN INDEPENDENT SCIENTIFIC SURVEY.



THE FAMOUS MODEL #111
111K \$79.95
111W \$139.95
Incl. Carrying Case & Cover



THE FIRST LOW PRICED
7" COLOR SCOPE
300K \$199.95
300W \$199.95



LOW PRICED 5" SCOPE
315K \$49.95
315W \$84.95



THE FIRST AND ONLY
8 1/2" COLOR SCOPE
308K \$129.50
308W \$229.50



LOWEST PRICED
WIRED 4 1/2" VTVM
909K \$25.98
909W \$37.50



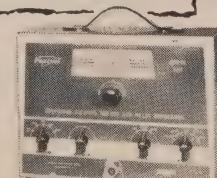
RF-AF-BAR GENERATOR
with pre-assembled head
630K \$33.95
630KA* \$38.95
630W \$53.95
PTAK \$33.95
PTAW \$33.95



THE FINEST VOLT, REG.,
7" VTVM KIT
9071K \$35.95
9071W \$49.95



LOW PRICED RF SIGNAL GENERATOR
"BEST BUY" IN GEN. FIELD
610K \$23.95
610KA pre-assembled head \$28.95
610W \$39.95



UNIV. AF, SINE, SO, & PULSE GEN.
635K \$33.50
635W \$52.50

Prices slightly higher in the West. Prices and specifications subject to change without notice.

WRITE FOR CATALOG RE 11-6

SEE THE MANY MORE PRECISE INSTRUMENTS AND PROBES AT YOUR DISTRIBUTOR TODAY

precise DEVELOPMENT CORP. Oceanside, New York, U.S.A.

Rohn

only complete line of TV and COMMUNICATION TOWERS

proven in Profits and Customer Satisfaction

look at these
ROHN exclusives

• HOT DIPPED GALVANIZED

The finest, most durable finish is available for ROHN Towers and accessories... all done entirely on the ROHN premises under careful ROHN supervision.

• UNEQUALLED DESIGN AND ENGINEERING

ROHN is the only design that has stood up over the years. ROHN has been first and foremost... and always the leader in new products to meet the changing demands.

• MASS PRODUCTION FOR LOW COSTS

ROHN was the first to utilize mass production techniques to build a superior tower at the most competitive prices. This means no sacrifice in quality yet far greater profits for you.

• UNIVERSAL CUSTOMER ACCEPTANCE

Thousands and thousands of installations prove the ROHN line first in customer satisfaction.

• PIONEER MANUFACTURERS

Pioneers in tower manufacturing—and today one of the world's largest manufacturers of this type equipment. The ROHN Company was built on satisfaction on the part of distributor, dealer and customer alike.

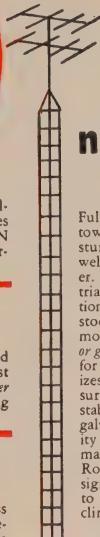
• COMPLETE LINE

Only ROHN offers a full line—one dependable one-stop source for all TV installation equipment. Save headaches, save shipping costs, save time... use ROHN unequalled service exclusively.

ALSO a full line of ROHN ACCESSORIES

Rotor posts, house brackets, eave brackets, peak and flat roof mounts, instant drive-in bases, hinged base sections, telescoping mast bases, guying brackets, UHF antenna mounts, erection fixtures, variety of mounts and supports for masts or tubing,

• • • • HIGHLIGHTS OF THE ROHN LINE • • • •



no. 6 tower

"All-Purpose" tower.

Fulfils 75% of your general tower needs—is structurally as sturdy—yet costs less than the well-known Rohn No. 10 Tower. Ideal for home and industrial installations, communication requirements... eliminates stocking many different tower models. Self-supporting to 50 ft. or guyed to 120 ft.! Easy to climb for fast, efficient servicing. Utilizes "Magic Triangle" which insures far greater strength and stability. Permanent hot-dipped galvanized coating. Dependability—a feature customers demand—is assured with the Rohn No. 6 Tower... designed to "stand up" for years to the rigors of weather and climatic conditions.

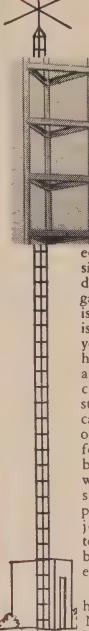


Package Tower

"Space Saver"—cuts storage space 300% or more!

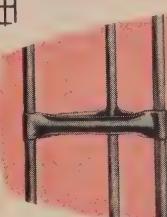
Popular PT-48 has almost 50' of sturdy tower within a compact 8' x 20" package! "Magic Triangle" design is adapted to a pyramid shape using a wide 19" base with progressively decreasing size upward. Decreases your overhead... easy to transport and assemble—cuts shipping costs. Galvanized throughout. Available in heights of 24, 32, 40, 48, 56 and 64 feet!

COMMUNICATIONS TOWER



For extreme heights and communication purposes of all kinds, the Rohn No. 40 gives you strength and durability on which you can depend. The time tested and proven equilateral triangle design using extra heavy duty tubing and corrugated steel cross-bracing is utilized. The No. 40 is structurally sound so you can install it for heights up to 300'; or at lesser heights when considerably greater strength is required because of excessive wind or antenna loading. Use for radio telephone, broadcasting, microwave relay and all other such communication purposes. If a particular job calls for this type tower, save real money by using ROHN towers.

Note: For lesser heights, use the Rohn No. 20 or No. 30 Tower.



Bath Towers Feature THE ROHN MAGIC TRIANGLE

For structural superiority, famed wrap-around "magic triangle" design is featured in these all-steel towers. Towers have full 2½" wide corrugated cross-bracing welded to tubular steel legs. The exclusive design assures dependable strength and permanence.

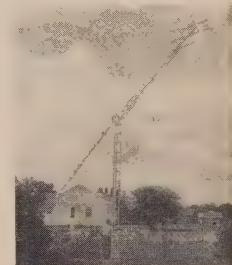


Telescoping Masts

Heavy-duty hot-dipped galvanized steel tubing and rigid joints give extraordinary strength. Quick installation... mast attached to base—antenna fixed, then mast hoisted quickly to desired height. Utilizes special clamp and guy ring arrangement. Flanged interior section; crimped exterior section gives mast stability that can't be beat. Complete with guy rings and necessary erection parts. In 20, 30, 40 and 50 ft. sizes. Bases and ground mounts available.

ROHN FOLD- OVER TOWERS

These unique fold-over towers are perfect for experimentation, TV service departments, amateur use, and special purposes. Uses regular ROHN tower sections with kit. Now available in standard No. 10 tower to 50', and in ROHN No. 30 & No. 40 towers for heavy-duty use.



MAIL THIS COUPON FOR FREE LITERATURE!

Rohn Manufacturing Company
116 Limestone, Bellevue
Peoria, Illinois

Gentlemen: Please rush me complete details on the full line of Rohn Towers and Accessories.

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Name _____ Title _____

Address _____

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**Have fun-
save
money!**



The MASTER

The MASTER is truly a masterpiece that can be seen and should be heard! The finest principles of acoustic engineering and the most tasteful elements of styling have been lavished on it. Each component of the MASTER is unique in design which contributes to its overall magnificence. Just listen to the sonorous "big theater" 15" woofer, the rich full-bodied middle produced by exclusive "reciprocating flare" horn with heavy duty compression driver and the crystal clear, natural highs emanating from the super-tweeter—all kept in perfect balance by the famous Acoustic Baton 3-way crossover network. A true cornerless-corner enclosure. It can be used flat against wall or in a corner. Unusually low price! Mahogany \$285.00, Blond \$290.00

BUILD THIS MAGNIFICENT SPEAKER SYSTEM *It's so simple!*

"DO-IT-YOURSELF" KWIKITS — You can build your own version of the fabulous MASTER with a KwiKit, University's "do-it-yourself" enclosure kit. With this truly amazing kit, you don't end up with a "cheesebox"! You do end up with an enclosure as good as the finest factory-assembled enclosure, in construction and design.

The KEN-15 KwiKit is similar in every respect to the MASTER, except that the KwiKit employs a simplified front frame design. It's so easy to assemble . . . almost all you need is a screwdriver. 3/4" cabinet plywood used throughout. Finest 3/4" Birch hardwood used for all finishing surfaces. Kit contains: all pre-machined and pre-shaped wood sections; glue; hardware; plastic wood; sandpaper; easy-to-follow instructions. *If you like to build your own and save money then the KwiKit is made to order for you.*

KEN-15 KwiKit \$49.75 net.

THE EN-15 ENCLOSURE is the exact enclosure used in the MASTER system; minus the speaker components. University makes this enclosure available for those who either have speakers or intend to build toward the MASTER in successive stages, via P-S-E.

Mahogany \$125.00 net. Blond \$130.50 net. Unfinished \$102.00 net.

THE COMPONENTS THAT MAKE THE MASTER A MASTERPIECE



LISTEN

University sounds better

UNIVERSITY LOUDSPEAKERS, INC., 80 SOUTH KENSICO AVENUE, WHITE PLAINS, N. Y.

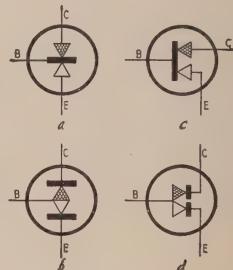
Correspondence



NEW TRANSISTOR SYMBOLS

Dear Editor:

The letter from Mr. Pugh in the August issue brought a lot of questions to my mind about the way transistors are drawn. To a man experienced in tube circuitry the transistor diagrams don't seem to contain the necessary information to make the circuit understandable at a glance. I would like to go Mr. Pugh one step further and suggest that transistors be shown logically as well as physically.



THE P-S-E STORY

P-S-E-Progressive Speaker Expansion plan (a concept first introduced by University) is the most revolutionary development in speaker history. University speaker components, enclosures and networks have been so uniquely designed that it is possible to start an excellent basic system at low cost, and add to it later—while enjoying immediate listening satisfaction.

P-S-E makes it possible to build up to the MASTER (or any other fine system) in successive, inexpensive steps, using the KEN-15 KwiKit and EN-15.

For the complete, fascinating story of P-S-E please send for FREE illustrated brochure.

In the Gernsback Library book on transistors it states that a transistor is basically two diodes. If this is true then why not draw them as such? For instance, Fig. a shows a p-n-p junction transistor. The collector could be shaded and then identifying letters would be unnecessary. Or, it could just be understood that the collector is always drawn on top. An n-p-n junction type would be drawn as at b, with c representing a point-contact p-n-p, and d a point-contact n-p-n. [A base is of one material, whether p or n. Mr. Lafferty's symbols would show what appears to be two in n-p-n transistors.—Editor]

With these symbols the diode action is clarified, voltage polarities and current flow become obvious. A circuit using these symbols is easy to understand and would make the transition from tubes to transistors much simpler. And the newcomer will have to be taught only diode theory to be able to understand transistors.

DON LAFFERTY

Electro Data Division of Burroughs Pasadena, Calif.

IMPROVED LIGHT COMPUTER

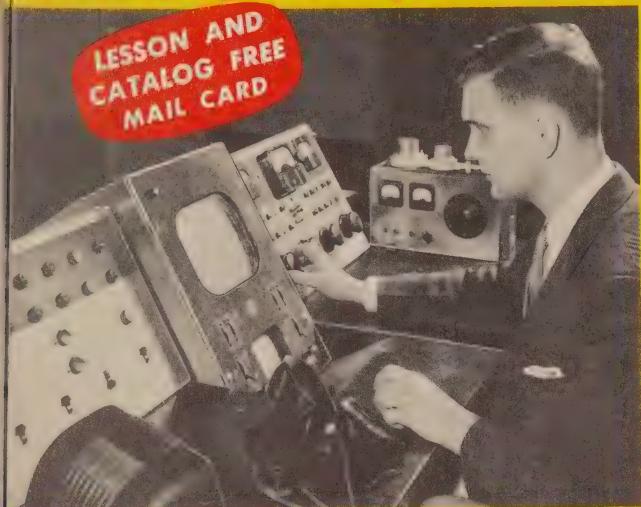
Dear Editor:

In the September issue of RADIO-ELECTRONICS we noted with great interest (Continued on page 24)

You Can Train at Home for Good Pay Jobs in RADIO-TELEVISION

Fast Growing Industry Offers Good Pay, Security, Bright Future

LESSON AND
CATALOG FREE
MAIL CARD



Add to Your Income Starting Soon

Make \$10-\$15 a Week Extra
Fixing Sets in Your SpareTime



Soon after enrolling, many N.R.I. students start earning extra money fixing neighbors' radio sets. Many earn enough extra to pay entire cost of course and provide capital to start their own full time Radio-TV business after getting N.R.I. Diploma. If you want a job with a future, find out how you can train at home for Radio-Television. Mail Postage Free postcard for Sample Lesson. See how practical it is to learn at home. Get 64-Page Catalog, too. See equipment you get, outlines of courses, facts about opportunities in this growing field. Prices of N.R.I. Courses are low, terms easy.

I.R.I. Training leads to good pay jobs like these. **BROADCASTING:** Chief Technician, Chief Operator, Remote Control Operator. **SERVICING:** Home and Auto Radios, P. A. Systems, Television Receivers, Electronic Controls, FM Radios, Hi-Fi. **SHIP AND HARBOR RADIO:** Chief Operator, Assistant Operator, Radiotelephone Operator. **POLICE RADIO:** Transmitter Operator, Receiver Serviceman. **GOVERNMENT RADIO:** Operator in Army, Navy, Marine Corps, Coast Guard, Forestry Service Dispatcher, Airways Radio Operator. **IN RADIO PLANTS:** Design Assistant, Transistor Design Technician . . . AND MANY OTHERS.

N.R.I. TRAINED THESE MEN

Thanks N.R.I. for Good Start

"Right now I am doing spare-time repairs on Radios and Television. Going into full time servicing soon." C. HIGGINS, Waltham, Mass.

Engineer with Station WHPE
"I operated a successful Radio repair shop. Then I got a job with WPAQ and now I am an engineer for WHPE." VAN W. WORKMAN, High Point, N. C.

Quit Job to Start Business



"I decided to quit my job and do TV work full time. I love my work and am doing all right financially." W. F. KLINE, Cincinnati, Ohio

N.R.I. Started His Way up

"I was a cab driver earning \$35 a week. Then I enrolled with N.R.I. Now tester with TV maker." J. H. SHEPHERD, Bloomington, Ind.

Training PLUS OPPORTUNITY is the ideal combination for success. Today's OPPORTUNITY field is Radio-Television. Over 125 million home Radios plus 30 million sets in cars and 40,000,000 Television sets mean big money opportunity for trained Radio-Television Technicians. More than 4,000 Radio and TV Broadcasting stations offer interesting and important positions for technicians, operators. Color Television, portable TV sets, Hi-Fi, other developments assure future growth. Radio, Television are both growing. Need for trained technicians is increasing!

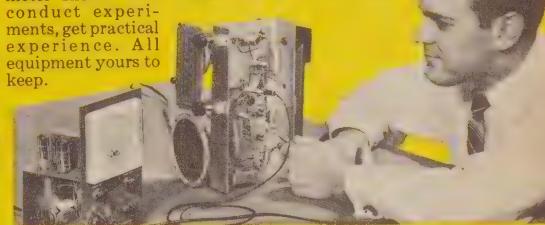


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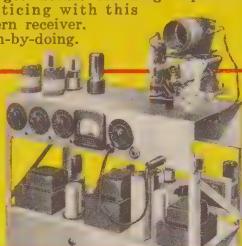


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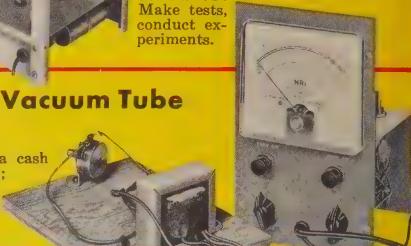


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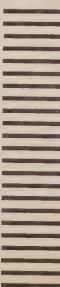
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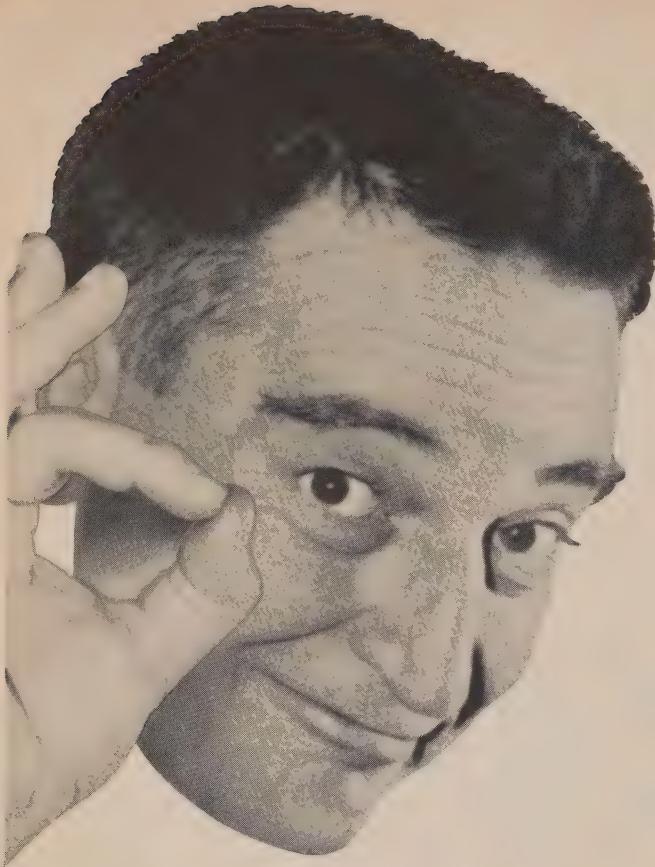
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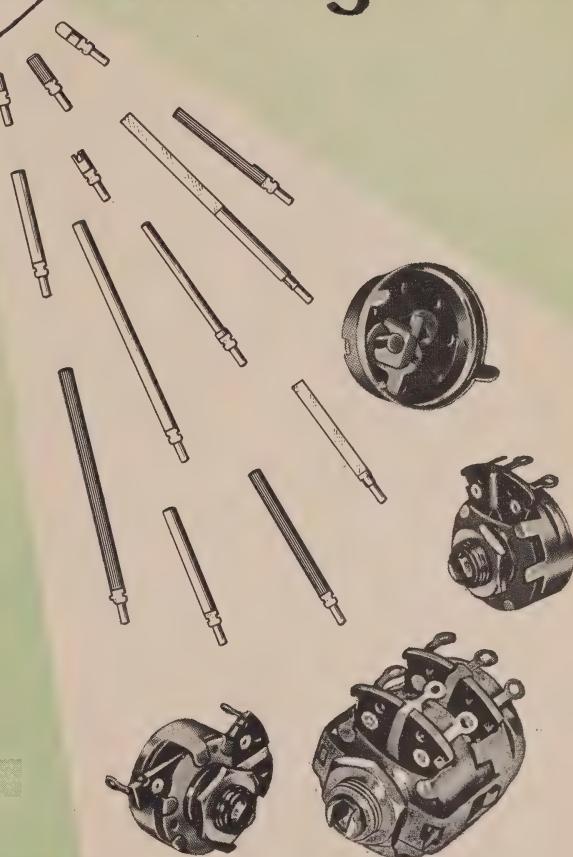


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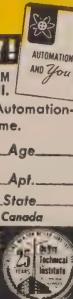
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CORRESPONDENCE

(Continued)

(Continued from page 18)

terest the article *Photoelectric Light Computer*. After reading the article I checked on the spectral response of the 868 phototube, which is the type used with the computer. The 868 has an S-1 response which is more sensitive in the red and infra-red. The 1P29 phototube is electronically identical to the 868 in all respects except that it has an S-3 spectral response, mainly in the blue, green, violet region.

Since photographic paper is most sensitive to blue light, it would appear that the 1P29 phototube would make the light computer much more effective and sensitive for the purpose for which it was intended.

E. V. WEINER

Iowa City, Iowa

MORE ON SYMBOLS

Dear Editor:

Allow me to explain the "mysterious nonnafarad (n)" you mention in your editors note to a letter by Mr. Haas in the July issue. The letters nF means 19°F. In other words, 1 nF equals 1,000 pF (μ F).

The reason for its use is that—in the German language area at any rate—it is customary to express capacitance below 0.1 μ F in picofarads [little farads, or micromicrofarads.—Editor]. What in the Anglo-American countries is .005 μ F, is 5,000 pF in the German area. As it is impractical to print so many zeros on a diagram an abbreviation was expedient. Thus, .005 μ F or 5,000 pF could simply be expressed as 5 nF.

It has also become practice to simplify symbols when no ambiguity exists, i.e., M for $M\Omega$, K for kilo-ohm and just the arithmetic figure for values below 1,000 ohms. Similarly, for capacitance the letter F is sometimes omitted from μ F, nF and pF, leaving only μ , n and p.

The three-part designation (1 M 2) that you mention in connection with a Yugoslav magazine is, I believe, a more or less private code of Philips (Holland). The first figure indicates wattage rating or working volts, the letter and last figure indicate the value of the component. This code is rarely used.

Finally, I'd like to express disagreement with Mr. Haas' criticism. Not that there weren't those differences in symbols, but they are much smaller than the differences in the languages and simply have to be translated together with the rest.

I personally find the lack of standardization of circuit symbols and layouts much more trying. For example, some French magazines print values horizontally, inductors and transformers are drawn like resistors, although these are standardized by the ICE.

ROBERT T. BLACH
Wimbledon, England

END

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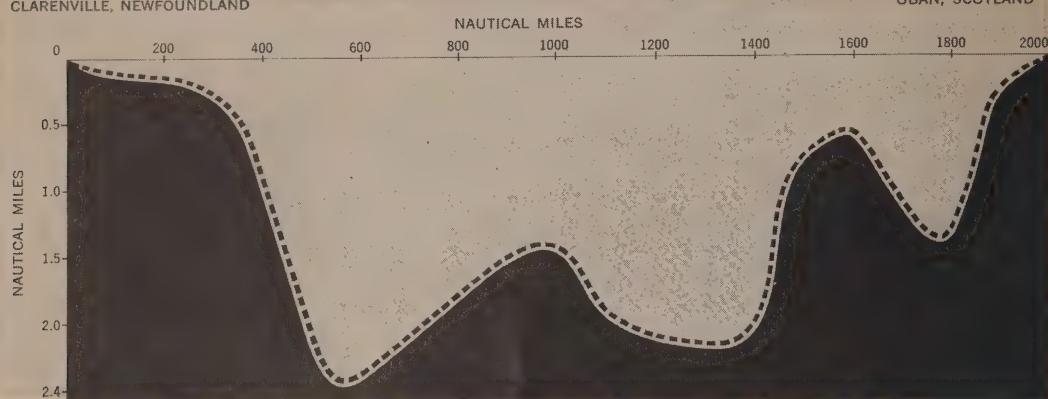
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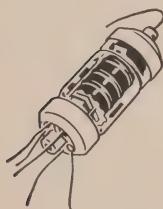
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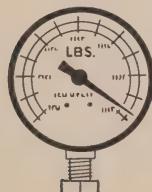
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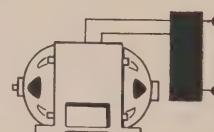
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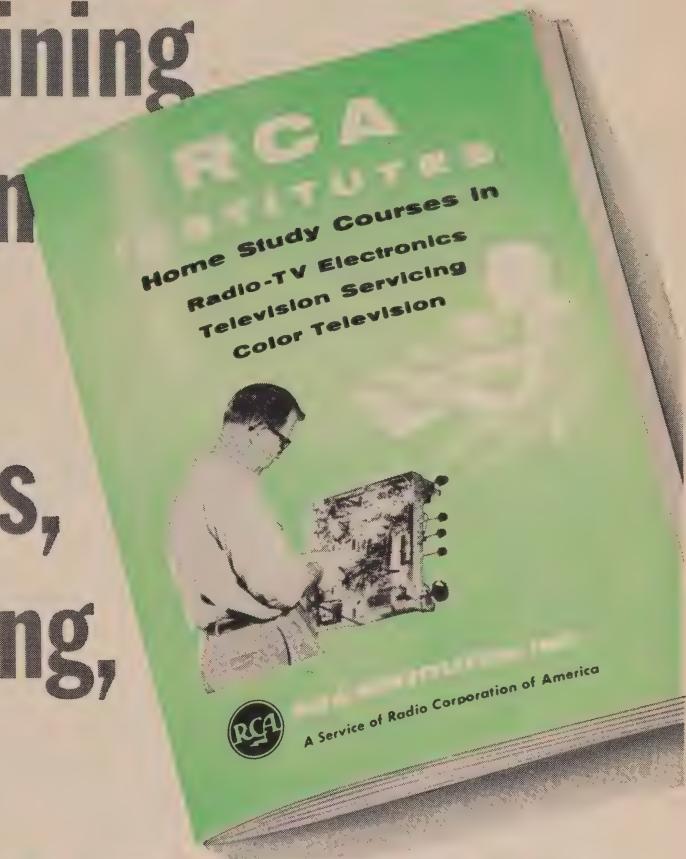
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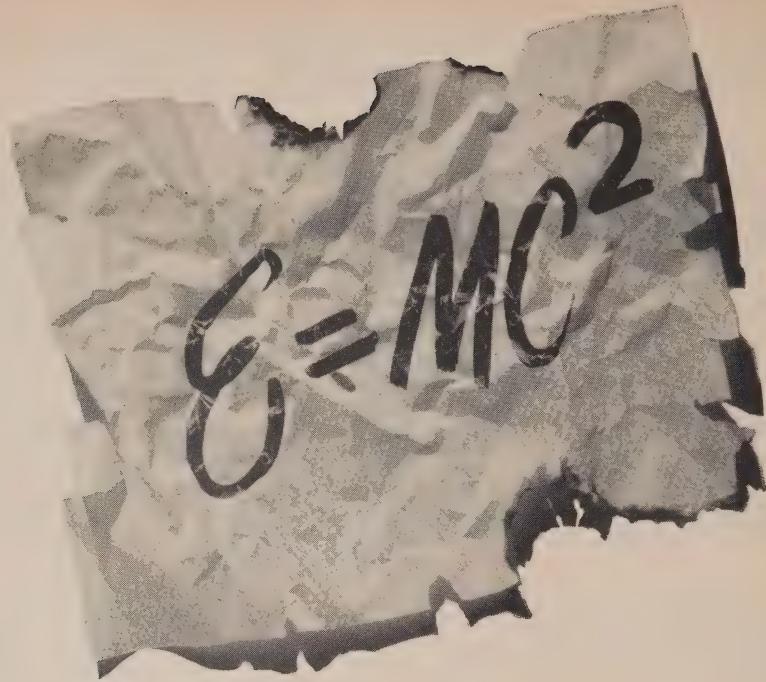
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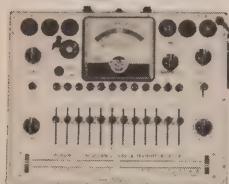
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TECHNICIANLESS AGE?

... Is a Self-Servicing Receiver Possible? ...

DURING a recent visit to Mexico City, we talked to a number of people about the progress of radio electronics and television in Mexico. As in all up-to-date countries today, Mexico is advancing rapidly from a technical viewpoint.

One of our friends, an American who has lived in Mexico for many years, deplored the fact that their technicians were far behind the times, so much so that he would not allow one to take his set off the premises "because it would surely be wrecked." We told him that no country had a patent on this situation—exactly the same thing happens in many instances in the United States and elsewhere. There are "technicians" and technicians in every country, some good, some mediocre, some bad.

At this juncture an electronic manufacturer, a native of Mexico, advanced the theory that sooner or later electronics would advance to such a state that the service technician would become obsolete. He maintained that it should not be too difficult to construct radio and television sets so that they would be "self-servicing." In other words, if a set became inoperative, you would press a special button and the set would then start to analyze itself, making all necessary corrections, rejecting useless parts and putting new ones into the circuit, until the set was restored to its original state and efficiency. He maintained that this was by no means science-fiction and that some day it would be done.

We would be the first to deny progress in this direction; indeed, on this page we have from time to time presented similar—if not quite such far-fetched—ideas. In this age of automatism, hardly anything is impossible when it comes to electronics. But it is also true that what is possible may not always be practical.

Indeed, in our most modern electronic calculating and computing machines, the so-called electronic brains, these same ideas have been used for some time. Thus, for instance, when vacuum tubes burn out or no longer render service an automatic circuit flashes a red light so the attendant can change the incapacitated tube. But incorporating expensive automatic gadgets into the average television set, while quite feasible, would run up the cost of the receiver out of all proportion. If anyone—and there are millionaires who can afford it—could spend anywhere from five to ten thousand dollars for a foolproof television set that could correct and remedy all or nearly all of its operating faults—such sets could, of course, be built. But how much of a market would there be for this type of receiver? It is conceivable that such sets could be made and sold in inaccessible locations where servicing technicians could not be had for any price, if the owner cared to spend the money.

But in spite of all the automatic regenerating features, it is doubtful that any self-servicing set could be constructed that would be absolutely foolproof under all circumstances. Suppose lightning hit the antenna? What then? Automation would be of no help in such a case. Suppose that there had been a flood and the set had been submerged in water. It would be hopeless to expect electronics to repair such a damaged set. Fire on the premises and other accidents, such as dropping the

receiver on the floor, would all tend to make the receiver inoperative in spite of the best electronic engineering.

On the other hand, it must be admitted that, as electronics advances, manufacturers tend more and more to make sets more foolproof than were our first radio sets of the Twenties.

We have mentioned before on this page that certain parts of television and radio sets can be engineered in such a manner that by taking out a "block unit" where trouble is most apt to arise and replacing it with a new block, the set can be made operative again—but not in all instances. There remains the great problem which haunts most service technicians—the *intermittent receiver*.

An intermittent can occur in dozens of spots and locations in a receiver. It may be a loose connection or a plurality of loose connections, not only in the wiring but in the components themselves. It is true that some intermittents, due to poor connections, could be eliminated by soldering the connecting wires to the tube prongs and at all other points where plug connections are now made. Internal intermittents could be reduced by increasing quality of components, all at a cost.

These are the imponderables of servicing and no degree of automation could eliminate such faults when and if they develop. They are the most time-consuming and vexing difficulties in servicing and so far have resisted all the ingenuity of engineers and manufacturers. There does not seem to be anything in sight—at least, not economically—to do away permanently with all intermittents in our commercial sets today.

Components for civilian electronic equipment are rated lightly as a rule. A municipal engineer who had his set in for service was startled to hear that a 600-volt capacitor would break down on a 50% overload and said that all electrical equipment for the city had to take 600% overloads for short periods and 660-volt stresses across insulation permanently, to be accepted. A TV set so made might cost two or three thousand dollars but could conceivably run for a number of years—with regular tube replacement of "reliabilized" tubes—with-out servicing.

While we now actually have automatic, nonhuman "service technicians,"* even these ingenious and expensive gadgets will not locate an average intermittent. Such a machine, it is true, will tell you that *there is* an intermittent or open circuit but exactly where it is, no machine will be able to indicate, at least not in the immediate future.

In this discussion, we have not begun to touch upon servicing color television sets, which multiplies the hazards of nonfunction almost in geometrical proportion.

We must therefore come to the inevitable conclusion that servicing technicians need not begin to despair of their profession. It is still human ingenuity, know-how and a thorough knowledge of electronics and all that goes with it that will reign in the servicing field, not only for the predictable future but for the distant future as far as it can be foreseen today.

—H.G.

*See RADIO-ELECTRONICS for July, 1956, page 55.

AN ELECTRONIC

SCOPE PROBE

*Low-capacitance unit
may be used with
any oscilloscope; bandwidth exceeds
10 mc*

R4
R2
C3, C4
C2

6BK7-A

Closeup shows construction of the low-capacitance oscilloscope probe.

By CHARLES W. RHODES

MANY television technicians get inaccurate and confusing results from their oscilloscope because they are not using a properly operating low-capacitance probe. These probes reduce circuit loading by the oscilloscope so that true operation may be observed.

The design of the conventional low-capacitance probe depends greatly upon the length of input cable and the input resistance and capacitance of the oscilloscope. Many scopes used in television shops are of such design that their input resistance and capacitance may

vary with control adjustment, making it impossible to use such a probe. Under these conditions conventional probes attenuate the input signal greatly and low-gain scopes are not sensitive enough to make up this loss.

The electronic low-capacitance probe overcomes these difficulties and has no circuit adjustments. It may be used with any oscilloscope. Its bandwidth extends beyond 10 mc and produces only a 5% voltage loss. Input capacitance is under 5 μuf and input resistance exceeds 15 megohms.

An oscilloscope with a shielded input cable may represent a circuit load of 2 megohms and 120- μuf shunt capacitance. The conventional low-capacitance probe uses the circuit shown in Fig. 1. The scope input resistance is R2 and its shunt capacitance, including cable, is C2. By making R1 much greater than R2, input resistance can be increased. For proper frequency response the time constant formed by R1-C1 must equal the time constant R2-C2. Normally, C1 is a small trimmer capacitor in the probe; its exact value is determined by experiment.

Fig. 2 shows the results of errors in the value of C1. In Fig. 2-a, the value is correct and the composite video waveform is undistorted. In Fig. 2-b C1 is too large and the horizontal sync is above the vertical sync, a condition known as "high peaking." In Fig. 2-c C1 is too small and the vertical sync is too high. Note the rounding off of the pulse. The value of C1 depends upon

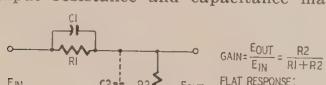


Fig. 1—Frequency-compensated voltage divider as used in low-capacitance probes.



Fig. 2—Frequency distortion on composite video waveform: a, C1 correct; b, C1 too large; c, C1 too small.

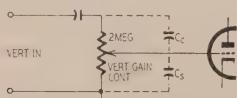


Fig. 3—High-impedance gain-control circuit used in some oscilloscopes.

the scope input characteristics and cable length.

Some oscilloscopes use a high-impedance vertical gain control circuit as shown in Fig. 3. When the gain control is near minimum, high frequencies are fed across the control by C_c, the stray circuit capacitances. Waveform distortion as shown in Fig. 2-b results. At higher gain stray capacitance C_s bypasses the high frequencies, producing the waveform at Fig. 2-c. At full gain C_s shunts the input circuit, throwing additional capacitance across the input terminals which unbalances the low-capacitance probe.

Other scopes use a low-impedance vertical gain control, avoiding the above trouble, but use an input attenuator switch which does not always present the same input resistance and capacitance to the input terminals.

Many of these instruments can give excellent performance if this one design limitation is removed—which is what the electronic low-capacitance probe can do.

Low-capacitance probe circuit

This probe (Fig. 4) uses a 6BK7-A as a cathode follower. While this type of circuit provides no voltage gain, it does have an extremely high input impedance and a very low input capacitance. With a 6BK7-A, using one section only, a voltage "gain" (A) of 0.95 is obtained. While grid resistor R1 is shown as 820,000 ohms the action of the cathode follower is to increase this

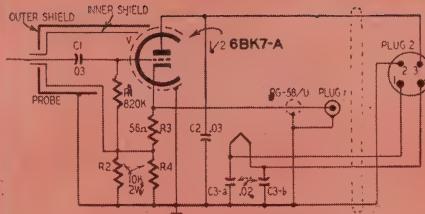


Fig. 4—Schematic diagram of the low-capacitance probe and power supply.

value by $1/(1-A)$ times so that it approaches 16 megohms as far as the circuit under test is concerned.

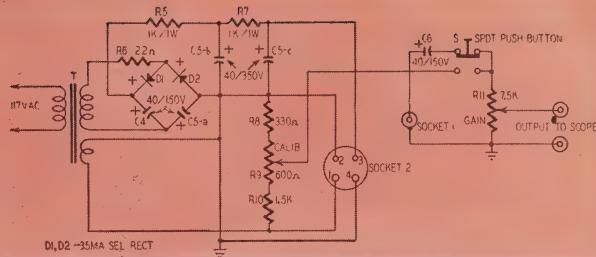
The inner shield of the probe completely shields the grid circuit from the outer shield by its coaxial construction. The inner shield is connected to the cathode of the 6BK7-A. Thus, there is virtually no grid-to-ground capacitance in this type of design. Instead, there will admittedly be a high grid-cathode capacitance. However, another property of a cathode follower is to degenerate any capacitance between its grid and cathode by $(1-A)$. With a gain approaching unity, this capacitance is washed out. The only other input capacitance is that of grid to plate, nearly half the total input capacitance. Therefore one section only of the 6BK7-A is used. The increased gain which would result from using both sections is marginal and would be more than offset by the increased capacitance and power supply requirements. While other triodes can be used, one section of a 6BK7-A looked best.

The output impedance of a cathode follower is extremely low. This probe has an output impedance of 100 ohms. The cable capacitance does not therefore attenuate frequencies below 12 mc. With the high input resistance afforded by the cathode-follower connection, low-frequency response is excellent.

An accessory power supply was built to furnish 240 volts at 18 ma and 6.3 volts at 450 ma. However most constructors will prefer to obtain this modest power from their oscilloscopes. It is extremely important to bypass the B-plus line with at least 40 μ f. The decoupling resistor should be chosen to deliver not over 240 volts maximum to the probe.

When the probe is to be used with an instrument having a high-impedance gain control, the low-impedance gain control unit consisting of R11 and C6 should be added to the instrument. Set the high-impedance control to maximum and use only the low-impedance control. Short unshielded leads should be used to connect R11 to the instrument.

A voltage calibration feature is included on the power supply chassis. Depressing PB feeds a 60-cycle calibrating voltage into the gain control.



Parts for low-capacitance probe

R1—820,000 ohms, $\frac{1}{2}$ watt	C5—40 μ F, 150V, 40-40 μ F, 350V
R2—10,000 ohms, 2 watts	C6—40 μ F, 150 volts
R3—50 ohms, $\frac{1}{2}$ watt	D1—selenium rectifier, 35 ma
R4—10,000 ohms, 2 watts	D2—selenium rectifier, 35 ma
R5—1,000 ohms, 1 watt	T—isolation transformer, secondary 117-volt @ 35 ma, 6.3 volts @ 1 amp
R6—200 ohms, $\frac{1}{2}$ watt	—
R7—1,000 ohms, $\frac{1}{2}$ watt	S—pushbutton switch, momentary contact
R8—330 ohms, $\frac{1}{2}$ watt	PLUG 1—miniature 4-prong cable connector (male)
R9—500-ohm pot. linear	PLUG 2—single-contact coaxial connector for RG-59/U (male)
R10—1,500 ohms, $\frac{1}{2}$ watt	SOCKET 1—miniature 4-prong chas- sis connector (female)
R11—7,500-ohm pot. linear	SOCKET 2—single-contact coaxial connector (female chassis-type)
C1—.03 μ F, disc ceramic	V—6BK7-A
C2—.03 μ F, disc ceramic	Miniature socket, 9 pins
C3—.02 μ F, dual disc ceramic	Length of RG-59/U coaxial cable
C4—40 μ F, 150 volts	Line cord

Potentiometer R9 is adjusted to provide the same scope deflection as a 5-volt peak-to-peak signal at the probe input. This is 1.77 volts rms.

Construction

A $\frac{1}{4}$ -inch-square if shield has an RCA type phono jack installed in it. It projects through a $\frac{1}{8}$ -inch hole, and flathead screws hold it in place. The prod uses an RCA phono plug with a small finishing nail soldered in it. A piece of spaghetti insulates the nail. The body of this plug should be taped as it is at cathode potential, 90 volts. Cathode load resistors R2 and R4 are soldered to the phone jack and lie outside the inner shield. Inside the shield are R1, R3 and C1. The heater bypass and plate bypass capacitors lie between the two shields. The use of these exact capacitors is recommended for space reasons.

The coaxial cable, RG59/U, is soldered to the cathode pin of the tube

socket. This cable length is noncritical. A four-conductor unshielded power cable carries heater and B power to the probe. The heater should not be grounded in the probe.

The tube socket is bolted to an electrolytic capacitor mounting plate (three-tab small type) with 4-40 machine screws cut short. This particular mounting plate exactly accommodates the outer shield, another if can $1\frac{1}{4}$ inches square and 3 inches long, with spade bolts. A $\frac{1}{2}$ -inch hole in its end carries a grommet which will insulate and space the RCA phono jack and plug. The two cathode load resistors are soldered directly to the mounting plate and help space the inner shield.

The power supply was built from material at hand. R6 was chosen to limit the voltage output.

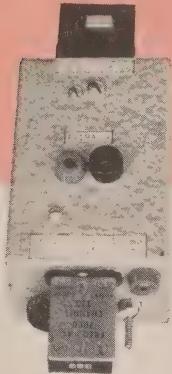
The high sensitivity and wide bandwidth of this probe permit its use in color servicing with an oscilloscope having a wide bandwidth.

END

The scope probe
and power supply.



Build a Dual WIDE-BAND CRYSTAL OSCILLATOR



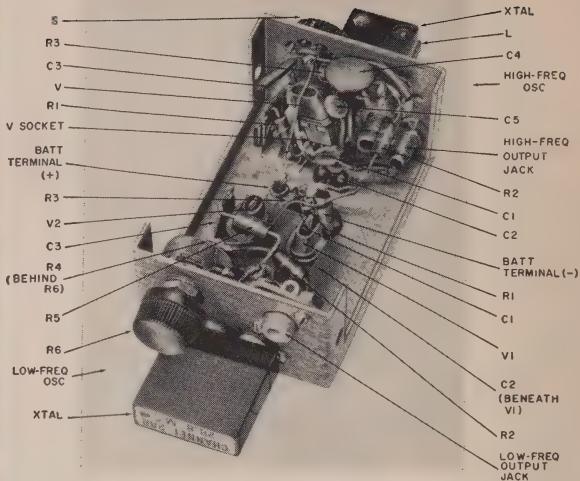
Unit contains terminals for external power supply — batteries may be inserted.

ACRYSTAL oscillator is accurate. It can provide frequency check points to calibrate the dial of a signal generator, receiver, wavemeter or vfo, and is nearly free from frequency changes. Drift is negligible. Voltage variations or circuit defects result in little if any frequency change. Furthermore, crystals are available on the surplus market, often several for a dollar.

When the crystal oscillator is transistorized the instrument becomes doubly useful for we gain the additional advantages of compactness and portability. This article describes two transistorized crystal oscillators: a circuit suitable for crystal frequencies from about 3.5 to 12 mc and one for crystals ranging from 80 kc to 1 mc. Each circuit covers a very wide band of frequencies without need for retuning every time the crystal is changed. The two were built in a single 3 x 2 x 1½-inch box, but can be constructed individually if desired.

3.5-to-12-mc oscillator

Fig. 1 shows the schematic of an rf generator, using a Raytheon 2N113 transistor, a high-frequency cutoff type suitable for this purpose. The power supply may be anything from 3 to 6 volts.



Layout of the dual oscillator.

Highly accurate separate transistorized units on single chassis cover 3.5 to 12 mc and 80 kc to 1 mc

By I. QUEEN

EDITORIAL ASSOCIATE

This circuit oscillates when its tank is nearly resonant with that of the crystal plugged in. Surprisingly, the lock-in range is greater than 2 to 1. With C5 switched out of the circuit, L is adjusted to tune to crystal frequencies from about 5 to 12 mc. Withdrawing the coil slug raises the frequency. In my instrument L was tuned to provide crystal-controlled frequencies up to nearly 12 mc, and the low limit was then about 5 mc. When C is added it lowers the tank frequency.

Preferably, this second band should just overlap the first. In this particular instrument a value of C5 equal to 270 μf provided a second band of frequencies from 3.5 to just over 5 mc, so the desired overlap is obtained. Therefore Fig. 1 can provide continuous coverage of crystal-controlled frequencies from about 3.5 to 12 mc. Once the desired band is chosen (by switching C5) any crystal may be plugged in without need to retune the circuit.

The output from this oscillator is the usual pure tone (when heard on a nearby receiver with beat-frequency oscillator) expected from any crystal-controlled circuit. There should be enough output to block a receiver coupled tightly to the oscillator. In most cases a loose hanging lead may be sufficient for coupling purposes.

Collector coil L is wound with 25 turns of No. 34 enameled wire on a $\frac{1}{4}$ -inch-diameter slug-tuned form. Once the slug has been tuned it need not be reset thereafter.

Tuning the oscillator

Plug in the desired crystal and switch on the oscillator. Listen in on a nearby receiver with bfo, tuning it approximately to the crystal frequency. When you find the signal it should sound pure

Parts for Fig. 1 oscillator

R1—1,500 ohms, $\frac{1}{2}$ watt	V—2N113
R2—270 ohms, $\frac{1}{2}$ watt	Xtal—see text
C1—120 μf	Batt—3-6-volt battery
C2—100 μf	S—switch, 4-position, Lafayette SP-88
C3—.005 μf	Crystal socket (Mosley 500 or equivalent)
C4—.005 μf	Transistor socket
C5—270 μf	Small chassis, about $3\frac{1}{4}$ x 2 x $1\frac{1}{2}$ inches
L—25 turns No. 34 enameled wire, $\frac{1}{4}$ -inch diameter slug-tuned form, closewound	Pin jack (for oscillator output)

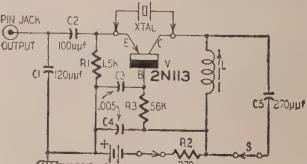


Fig. 1—High-frequency oscillator.

and clear, like a flute. The receiver antenna lead should be disconnected during this time or you may pick up considerable outside interference.

After the oscillator is found to be working correctly, adjust L as required. When a crystal frequency is outside the upper limit of the band, its tone (with receiver bfo switched on) may tend to sound rough. If the crystal frequency is too low for the band, its oscillations may be slow to start or it will not oscillate at all. Crystals within the band will sound clear and steady.

The reference to "12 mc" needs explanation. Surplus crystals with frequencies higher than 8 mc are not common. My own highest crystal is marked 8.775 mc. However, if a crystal of about 3.5–4.0 mc is plugged into its socket, it oscillates at its third overtone. This differs from a harmonic. An overtone is the lowest frequency available from a given crystal yet it is (nearly) an odd multiple of the crystal frequency. For example, a 3.7-mc crystal puts out a signal at nearly 11.1 mc in this circuit, and there is no trace of output at either 3.7 or 7.4 mc. The lowest oscillator frequency is approximately 11.1 mc. The overtone signal is much more powerful than if it were the third harmonic of the same crystal. For all intents and purposes, the crystal behaves just as if its fundamental is 11.1 mc, not 3.7.

The overtones of any crystal must always be odd. There can be no second or fourth overtone. In this circuit 80-meter crystals are effective only at their third overtone because the frequency comes out to about 11 mc, within the oscillator range when C5 is switched out.

Crystals with fundamentals near 3.5 mc do double duty in this oscillator. They oscillate normally at their labeled frequency when C5 is switched into the circuit, for then the band is from about 3.5 to 5.0 mc. When C5 is switched out, the output frequency is approximately three times the crystal fundamental.

If you listen to the fundamental output and then the overtone output, you will notice a much stronger signal available from the overtone; the harmonic will be weak. Also, you will note that the frequencies are not equal. For example, a 3.7-mc crystal has a third harmonic at exactly 11.1 mc. The overtone appeared about 15 kc lower, an error of about 0.14%. Other crystals may produce overtones a few kc above the harmonic. This error may be ignored for all practical purposes since it is so small.

The output frequency must be checked against a reliable standard before using a fundamental type crystal operating in the overtone mode or an overtone type on an overtone other than the one

calibrated by the manufacturer. This is doubly so when the oscillator is used as a transmitter control or in a calibrating device.

Ordinarily, we might expect to need two switches for this oscillator, one to close the battery circuit, the other to switch C5. Both functions have been combined through a special four-position switch (Lafayette SP-88). This is a tiny unit, less than $\frac{1}{2}$ inch deep and only $\frac{3}{4}$ inch in diameter. Fig. 2 shows a rear view of the switch terminals. When the knob is rotated fully counterclockwise (as viewed from the front), the common terminal (1) is isolated from the others. In the next position terminals 1 and 2 are shorted. In the third position terminals 1, 2 and 3 are shorted. The last position shorts all

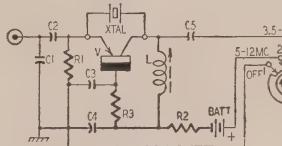


Fig. 3—Diagram of Fig. 1 circuit showing connections to switch terminals.

terminals, but this position is not used in this circuit.

Fig. 3 shows how the switch terminals connect to the oscillator. In the counterclockwise position battery power is disconnected. The next step closes the battery circuit but leaves C5 disconnected. The next step switches in C5 (through C4) for the lower-frequency band and the power remains on.

The crystal socket is Mosley No. 500 (or equivalent) for FT-243 crystals. The transistor socket is the usual five-pin in-line type. Emitter and collector pins of the transistor socket are soldered directly to the lugs of the crystal socket.

When used as an overtone generator the output is very strong even through TV bands. Thus it may be used to calibrate and align receivers and signal generators at these high frequencies. As previously stated, the overtone is not an exact multiple of the crystal fundamental frequency so the oscillator must be carefully calibrated before use as a test instrument.

80-kc-to-1-mc oscillator

Fig. 4 shows a transistor oscillator designed for low-frequency crystals. It is ideal for crystals, often advertised in the radio magazines at several for a dollar. This generator uses a pair of G-E 2N170 transistors, n-p-n units that require a negative bias on emitters and positive voltage on collectors. The transistors are coupled to feed back from one collector output to the other base input. Due to this regeneration the circuit tends to oscillate when a crystal is plugged in.

The highest frequency tried in this circuit is 1 mc. The lowest is 80.86 kc,

provided by a surplus type crystal purchased several years ago. It is type FM-6, manufactured by Crystal Research Labs, Hartford, Conn.

A number of low-frequency crystals have been tested successfully in the circuit. No tuning is required when changing from one crystal frequency to another. Not all these low frequencies fall within the broadcast band so they cannot be picked up directly on a broadcast receiver. However, their harmonics may be heard. For example, a 80-ke crystal has harmonics at 560 kc, 640 kc and so on and a 400-ke crystal has output at 800, 1200 and 1600 kc, in the broadcast band.

The output of a low-frequency generator such as this may be checked against a standard and then used for amplifier alignment. Thus, a variable attenuator is included. Also, the dc

Parts for Fig. 4 oscillator

R1—3,000 ohms	C2—.005 uf
R2—1,000 ohms	V1—2N170 transistor
R3—4,700 ohms	V2—2N170 transistor
R4—15,000 ohms	Xtal—see text
R5—1,500 ohms	Crystal socket
R6—1,000-ohm pot	Pin jack (for oscillator output)
All resistors $\frac{1}{2}$ watt	Transistor sockets (2)
C1—.005 uf	Common chassis and battery used for oscillators
C2—.005 uf	

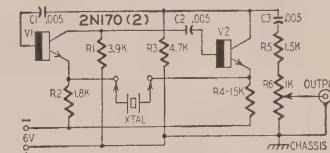


Fig. 4—Low-frequency oscillator.

component has been blocked out. The generator has a phono type jack that takes a coax lead.

Adjustments and applications

This circuit is not critical as to parts value or placement. However, try interchanging transistors for widest band coverage with least voltage input. If several transistors are available, use those that show greatest output in the band.

Among the useful applications of this circuit are: if signal generator, standard frequency source to calibrate Wien-bridge oscillators (by Lissajous patterns) and calibrating broadcast radios (by using harmonics).

For an extremely wide-band oscillator, both circuits may be included in the same instrument. The photos show such a device housed in an aluminum box $3\frac{1}{4} \times 2 \times 1\frac{1}{2}$ inches. A small 6-volt battery could be placed inside since there remains plenty of room. In this particular instrument, however, an external power supply is used. Note that both oscillators are separate circuits, therefore both can oscillate at the same time, if there is any need for such operation.

The high-frequency oscillator may be shut off by its switch. The low-frequency job has no switch but its output may be reduced to zero by the attenuator.

END

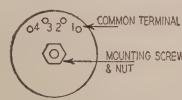
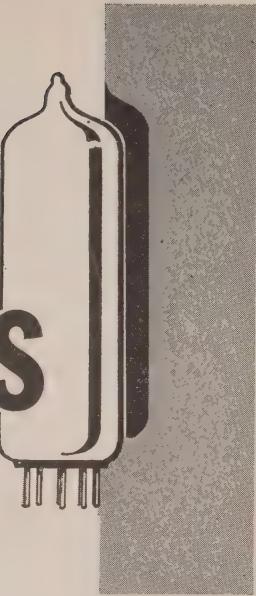


Fig. 2—Subminiature switch—rear view.

Tube Testers

** Valuable tools when properly applied. This article tells you how*

By WALTER J. SWONTEK



THE tube tester is one of the most valuable pieces of equipment a service technician can own. Since many are likely to disagree with this statement it might be advisable to change it to: A tube tester *can* be one of the most valuable pieces of equipment a service technician can own.

Practically all service shops own a tube tester of some sort. In many of these shops it is used only when a customer brings in tubes to be tested.

This article points out the many valuable uses to which tube testers can be put, and attempts to explain and overcome the prejudice in many technicians' minds against them.

Since a discussion of the merits of a tube tester is valueless when working against a heavy prejudice, let us see how this bias is produced and how entirely unfounded it is.

At the first contact with any sort of testing device, it is only human to expect a yes-or-no answer. In other words, the device is automatically expected to say: "Yes, the item is good" or "No, the item is bad." Actually, in real life, *very few things are definitely good or clearly and undeniably bad*.

Manufacturers cater to human weakness and provide a good-bad scale, clearly marked in red and green.

When such a device is offered, it is expected to be 100% accurate. In other words, the tester itself is judged on a "good-or-bad" basis. If 100% accurate, the tester is "good"; if not 100% accurate, the tester is "bad." Since nothing is absolutely perfect it is only

human to judge tube testers "bad."

What usually happens is that the novice technician becomes acquainted with a tube tester and learns how to manipulate the knobs. He puts the tube tester on a pedestal as a tin god or supreme judge of all tubes. His tube worries are over! All goes well for a while, and the novice is a rabid tester of tubes. His faith is implicit. He supports the tester ardently in discussions with more experienced technicians.

Then, one fatal day, the tube tester misses a bad tube. The bad tube is reinserted in the set and troubleshooting begins. All bad parts are replaced; everything is tested. The stubborn symptoms refuse to disappear. The technician becomes a nervous wreck. Finally, the help of a more experienced friend is sought. The friend swaps tubes and presto! the trouble is cleared. "But I checked that tube . . .," howls the novice. His friend just laughs with that horrible, superior air. The novice's faith in testers is completely shattered.

Now that we can see that this prejudice against tube testers is founded in unreasoning emotion (all prejudices are, really) we can inspect them for their real values.

The tester as tube salesman

Let us consider this red-green scale in a realistic light. Its purpose is to sell tubes! The control settings given on the charts are calibrated so that the average new tube will read well in the green. If a tube measures an

arbitrary percentage (usually 15% or 20%) below "normal," it will read in the red. This merely means that the tube is weak in emission (or transconductance on some testers) and not necessarily "bad" in the sense that it will not operate. However, the customer can accept the tester as a supreme judge, with the net result that we sell him a tube when his tests in the red, even though we know his old tube may work.

The function of a tube tester as a tube-selling aid is one of its most valuable uses and will, in fact, pay for its cost many times over. There need not be any sense of guilt connected with this selling. Most customers will usually buy a new tube even though they are told: "This tube will probably work, but it tests weak on the tester." The customer's logic is good. The tube tests weak, therefore it is likely to fail in the near future.

If the customer does not purchase a replacement for the weak tube, the technician has still gained several advantages: the customer is impressed with the technician's honesty; in case the set fails within the guarantee period, the customer is not as hostile when he brings it back. His thought is: "Maybe that weak tube went."

When the question of testing tubes for troubleshooting arises, the usual answer is: "Why bother? Swap them! That'll tell." This is true enough on the surface, and swapping tubes is a helpful maneuver. There are several disadvantages, however. If new stock is used for swapping, it soon degenerates badly. The cartons become shopworn and unusable. Unless extreme care is taken, used and defective tubes will work their way into the stock.

Many shops avoid the deterioration of their new stock by keeping a "bench stock" of tubes on the test bench for swapping. This is fine, but it represents an investment of a surprising number of dollars. In addition, the bench stock deteriorates rapidly. To prove this to yourself, take an afternoon when you are not busy and test the bench stock.

Advantages of tube testers

Tube swapping is not 100% accurate any more than a tube tester is! Swapping is accurate only when the substitute is known good. There can never be absolute certainty that it is.

One TV set was brought in for bench service. The outside man had (supposedly) swapped tubes. However, the bench man tested the tubes with a view of sales and found five defective (not just weak) tubes. This cleared all symptoms and the set required no further service. The only tube-swapping system that would have cleared the set would have been the insertion of a complete known-good set of tubes, followed by reinsertion of the old tubes, one at a time. This is time-consuming and not generally done by tube swappers. Had it not been for the tube testing, the bench man would have had a rip-snorting troubleshooting job.

A situation that arises repeatedly is the case of a circuit that contains both a defective component and a defective tube. The tube is swapped first, and, since no improvement is seen, it is reinserted. After the replacement of the defective component further troubleshooting is needed to find the bad tube. Here, the tester would most likely have caught it on the first try.

As another example, take the case of a tube with a heater-cathode short. If this tube is inserted in a set where one side of the heater and the cathode are grounded and if the short is from the cathode to the grounded side of the heater, the tube will work perfectly and be considered a known good. This may seem a long chain of circumstance, but anyone who tests many tubes will testify that it happens surprisingly often. Now, when this "known-good" (but actually defective) tube is used as a substitute, it can cause a diagnosis that leads to much fruitless troubleshooting.

Grid emission (not shown by the less expensive testers) also causes much confusion in tube swapping. If the tube is inserted in a circuit where the grid circuit resistance is very low, it may work perfectly and be considered a known good. This same tube inserted into another circuit with high resistance in the grid return will develop a positive voltage on the grid and cause many peculiar symptoms. The gas test on better tube testers catches these quickly.

The short test on tube testers is of more value to the bench technician than the emission or transconductance test. Any tube that shows an inter-element short can safely be considered defective (definitely "bad") and replaced. Circuits where the tube will work even though shorted are rare and the number of tubes unnecessarily replaced is negligible. If an intermittent short is suspected, the logical step is to tap the tube gently at each position of the short test.

The noise test present on some testers is seldom needed, but it is a life-saver when the occasion arises. Each tube can be checked for noise or microphonics separately with concrete, dependable indications.

Most of the preceding has been in favor of using the tube tester. However, this should not be taken as argument against tube swapping. The most profitable attitude a technician can take is to consider the tube tester as a valuable tool and tube swapping a valuable procedure, and use *both*.

The tube tester should be looked upon as a fact-indicating device, just as a voltmeter or ohmmeter, and not as a judge. The indications of the checker must be interpreted and judged, just as those of other test equipment.

A resistor measures 500,000 ohms. Is it bad? This reading of a resistor does not say whether it is good or bad. If it is marked 68,000 ohms, it is bad. Similarly, a 6K6-GT tests somewhat

low on emission. Is it bad? Well, let's see—if it is used in the sound output, the slight loss in volume may be unnoticeable. It will work, so we can consider it "good" or at least satisfactory. But wait—the focus coil is in the cathode of the sound output and the symptom is poor focus! Now, the interpretation is different. A new tube clears the trouble and the weak 6K6 is now considered bad.

When the disillusioned technician is ready to return to the use of a tube checker, he should also be ready to keep in mind the failings of most testers. The following is a list of common tube-tester shortcomings obtained from bench experience.

1. When a tube tester checks a tube "bad," the tester is much more likely to be accurate than when it says the tube is "good."

2. Rectifiers will often test in the green on emission test and still produce low B-plus voltage. This is because a tube may have sufficient emission to carry the dc required to test good and yet have insufficient emission to handle the peak currents demanded in actual operation.

3. Tubes used in high-frequency oscillators, such as the 6J6, will often test good and still refuse to operate.

4. Most power tubes, such as 6K6, 25BQ6, etc., operate at a much higher temperature in the receiver. If trouble shows up only after a long warmup, the suspected tube should be tested immediately upon removal from the set, while it is still hot.

5. High-voltage tubes, 1X2, 1B3, etc., are not tested under normal operation by most tube testers. A "good" test of one of these means little.

6. Certain tube type numbers, as those used in tuners, will show a strong tendency to test good and still refuse to operate.

Ten commandments for testers

A few general rules can be set up concerning the decision as to swap or check. These are merely guides to the use of the fastest and most convenient system.

1. In customers' homes it is generally much faster to swap tubes. A complete tube check is too time consuming. If the symptom is distinct and clearly indicates trouble in one specific circuit, the two or three tubes in that circuit can be changed quickly. In addition, carrying the tube tester is excess effort while the tube kit *must* be brought along for replacements.

2. When a set is placed on the bench and has many vague symptoms, it is wise to give it a complete tube test. Although new tubes will seldom cure the trouble completely, it will usually be found that defective tubes are causing *some* of the symptoms. Replacing these clarifies the remaining symptoms and makes troubleshooting easier.

3. If a receiver on the bench has one clear symptom, tube swapping is faster and more certain. For instance,

lack of width indicates changing the horizontal output tube immediately without bothering to test it.

4. When a set has a long history of recalls and general customer dissatisfaction, a complete tube test is very helpful in most cases.

5. When a stubborn symptom, definitely in one specific circuit, is met, use *both* systems. Test the old tube. Test a new tube, then swap.

6. When a technician is completely stopped on a symptom that is apparently in one specific circuit, it is wise to give the set a complete tube test. The various circuits in any TV set are usually not completely isolated from each other. Often a defective tube in a completely different section of the receiver will be found to be causing the symptom.

7. When in doubt, test *new* tubes. Only too frequently will it be found that entire "runs" of a certain tube number will develop the same defect shortly after being placed in a radio or TV receiver.

8. If a set has too simple a trouble, the profit may be too small to provide for a possible recall. A tube test here serves a dual function. It reduces the possibility of a recall, and also increases the profit to enable the technician to accept a recall on this set with better grace.

9. Sometimes a technician will gamble a new tube rather than pull the chassis, and he will replace a tube that might have been caused to go by a defective component. If the tube tester is handy and the new tube is tested before insertion, the technician will know if he has lost the gamble. Thus he will not wonder whether the new tube was bad in the carton.

10. When selling a tube over the counter, it is wise to test the new tube. This improves goodwill by preventing the sale of defective tubes. If the tube is of a type number that is often blown by defective components (such as a 35Z5), the customer should be warned of the possibility. This will avoid arguments over tubes burned out by the customer and should bring the set to the shop.

The tube tester is also a very valuable psychological tool. Most technicians detest having the customer look over their shoulder when they are working. If the customer insists on watching while the technician takes a look at his set, the tester gives the service technician something to do while inspecting the set for an estimate. A tube test is a much more satisfying show for the customer than the spectacle of a man probing around with a test prod, apparently aimlessly.

Thus, if the technician thoroughly understands what the tube tester actually does and how it does it, the results he obtains will not be mystifying. In addition, this knowledge will enable him to use it in original ways, developed to fit the circumstances of a particular situation.

END

calibrating AC voltmeters

*Cheap and accurate means
of supplying calibration
voltages for vtvm's*

by EDWIN N. KAUFMAN

CALIBRATING the ac scales of the common analyzer, voltmeter or vacuum-tube voltmeter is a problem not only for individuals but for many small laboratories with insufficient funds for calibration equipment.

Most laboratories calibrate their ac instruments by supplying an accurate ac voltage obtained from a "standard" transformer, with taps. The input voltage to the transformer is maintained manually at a fixed, accurate value by using a precision input ac voltmeter with a "set-to-red-line" scale. A standard transformer and voltmeter with appropriate tap switches usually sell for about \$750.

A transformer type calibrated ac voltage has the advantage that the impedance of the supply is very low and thus both low-impedance voltmeters or high-impedance vtvm's shunt the supply impedance very slightly and cause negligible error. If the impedance of the instrument is so low that a considerable amount of current is drawn, an error of about 1% for 100 ma will occur.

Another less common method of calibration is to use precision secondary standard voltmeters and then compare the standard to the instruments to be calibrated. This has several disadvantages: Meters (standard) are rated in percentage of full-scale accuracy which means that at any voltage less than full scale the accuracy may be much less. The standard meter must be read accurately many times to cover even a single voltage scale, as many ac meters are not linear. The standard dynamometer type of meter requires lots of power (several watts) which can be serious at times. The lowest voltage which can be indicated satisfactorily is—depending upon what you call satisfactory—from 0.3 to 3 volts. Since many vtvm's indicate as low as .001 volt ac, full scale, this means that many ranges cannot be calibrated. The cost can be as great as the standard transformer type of calibrator.

It was found impractical to calibrate ac voltmeters and analyzers (volt-ohm-

meters) directly because of their low impedance and high current requirements.

It is practical to make a very inexpensive calibrator capable of supplying voltages from 1.5 mv to 80 volts (with 2% or better calibration) for vacuum-tube voltmeters.

Once a vtvm has been calibrated it can be used as a standard for checking other meters. It is not the best method, but it is inexpensive and relatively accurate. If a vtvm, after calibration, is to be used as a standard for checking other ac meters, I can very strongly recommend using a Ballantine vtvm, as it has a logarithmic scale and thus the error is the same at either end. It is also a very reliable meter.

The circuit shown uses an inexpensive ac voltmeter as a standard. This meter is rated at 2% but, as it is used at one point only on the scale, much better accuracy can be obtained if the meter is calibrated.

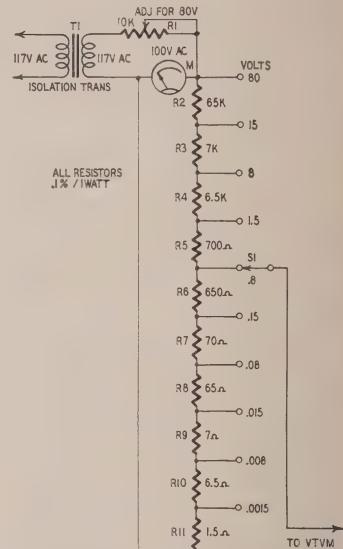
Without calibration the voltage calibrator should provide voltages within 2% or better and with calibration probably 1% or better. The resistors shown are all 0.1%, 1 watt, wirewound so that, although a string of them are used, the maximum error possible is 1%, but in actual practice all errors will average out to about 0.5%. The resistors can be obtained from the Hycor Co., 11423 Vanowen St., North Hollywood, Calif.

If economically possible, a line isolation transformer should be used in the circuit for safety; however, my personal calibrator does not use one.

The calibrating voltages were selected so that whether a vtvm indicated *high* or *low* the meter would still indicate on scale. In many cases two voltages are supplied per vtvm scale.

This circuit cannot be used on a regulated ac line but *must* be plugged into a regular power outlet as the calibration is dependent upon a pure sinusoidal waveform.

Some vtvm's are sensitive to line voltage and to waveform distortion. Therefore, on calibrating, it is advisable to calibrate under the condition the meter will normally be used. In



Schematic of the ac calibrator.

Parts for Calibrator

R1—10,000-ohm potentiometer
(can be 10-turn Helipot)

R2—10,000 ohms

R3—7,000 ohms

R4—6,500 ohms

R5—700 ohms

R6—650 ohms

R7—70 ohms

R8—65 ohms

R9—7 ohms

R10—6.5 ohms

R11—1.5 ohms

All resistors are 0.1%, 1 watt

T1—isolation transformer

M—0-100 volts ac meter

(Weston 476 or equivalent)

SI—1-pole nonshorting 10-position switch (Mallory 321[2] or equivalent)

Chassis—aluminum, approximately

5 x 4 x 3 inches

Mounting strips for resistors

other words, keep an eye on line voltage when calibrating or in use, unless the vtvm is stabilized by using a regulated ac power line. Remember, however, that the calibrator cannot be used on the average regulated ac line satisfactorily.

END

TV sets with . . . remote control

By HENRY O. MAXWELL

This, the third in a series on remote-control TV, covers split-chassis models



The Radio Craftsmen C210 chassis.

In our opinion, the split-chassis type of remote control TV set is highly practical for use in custom installations where the job is planned or completed at the time that the home is being built or renovated. Interesting circuit features of five sets are discussed here. The Conrac split-chassis type and several electronic and electromagnetic remote controls were discussed in the two previous issues.

Fig. 1 shows how the video and audio circuits are divided between two chassis in the Gotham 525 and 323 receivers. The tuner and if strips are on the control or tuner chassis. After detection, the video and audio signals are each amplified in a single stage and then fed through cathode followers and interconnecting cable to the deflection chassis. The deflection chassis is turned on by a 6-volt relay excited by ac from the tuner chassis. The circuit is conventional except for the use of cathode followers. Brightness is controlled only from the deflection chassis.

Douglas Chairside

The Douglas Chairside TV receiver is a 27-inch model similar to the Conrac 800. Fig. 2 shows the keyed agc and on-off circuits and the video circuits on the remote tuner chassis. The method of feeding flyback pulses to the agc keyer is a little different from the Conrac arrangement. The flyback pulses and 6 volts ac for controlling the remote

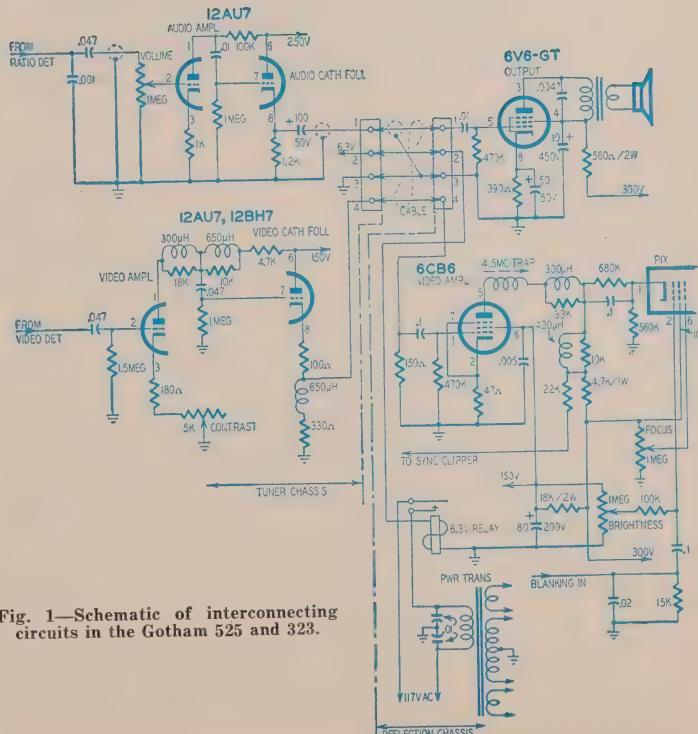
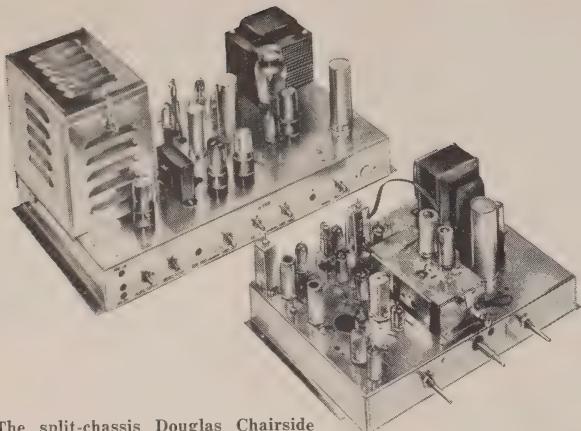
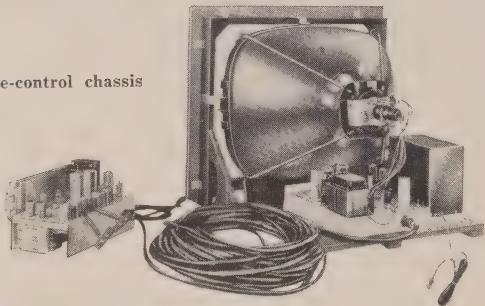


Fig. 1—Schematic of interconnecting circuits in the Gotham 525 and 323.



The split-chassis Douglas Chairside

Pilot TV-527 remote-control chassis



power relay are carried on a common pair of lines. A $5\text{-}\mu\text{f}$ capacitor prevents the interaction between the two circuits. Control voltage for the tuner is delayed and clamped by half of a 6AL5.

A 6U8 pentode-triode is the two-stage video amplifier. The pentode section is direct-coupled to the video detector. Resistance-capacitance coupling is used between the first and second video amplifiers. Contrast is controlled by a

potentiometer in the grid circuit of the second stage—a cathode follower feeding the low-impedance video line of the deflection chassis. Traps in the cathode circuits of the cathode follower and the third video amplifier (on the deflection chassis) eliminate 4.5-mc beat.

Pilot TV-527

Fig. 3 shows part of the remote tuner, including cathode follower and

age circuits of this receiver. A diode rectifier is used for age voltage. Contrast is controlled by varying a bias voltage applied to the age line.

The video circuits on the deflection chassis are shown in Fig. 4. A cascaded 12AU7 video amplifier drives the 6CL6 video output stage. Peaking is not used in the first two stages. Adequate response is obtained by using low plate load resistors and frequency-selective feedback between the cathodes. The second half of the 12AU7 feeds the grids of the 6CL6 and a 12AT7 cathode follower, which is used when connecting additional deflection chassis as remote viewers.

Half of a 6AL5 is connected between ground and the input to the 6AU6 sync clipper. This diode conducts and charges the $0.22\text{-}\mu\text{f}$ coupling capacitor to a peak voltage equal to the level of the sync tips. The time constant of the discharge circuit is longer than the sync interval so a negative voltage of about 20 appears on the diode plate. Thus, for all normal signals, the diode conducts only enough to maintain the charge on the capacitor.

If a noise pulse exceeds the level of the sync tips, it overcomes the negative bias on the plate, causing the diode to conduct and clip noise to the point where it does not affect sync stability.

Craftsmen C210

Pertinent interchassis features of this set are shown in Fig. 5. This set is designed for use with a separate af amplifier so the usual power amplifier is not included. Jacks for tapping the output of the audio cathode follower are provided on both chassis. Direct coupling is used between the first af amplifier and the cathode follower for good fidelity.

The contrast control on the tuner chassis is in the cathode return of the 6CB6 video amplifier on the sweep chassis. The lead to the remote chassis is bypassed by a $50\text{-}\mu\text{f}$ capacitor to prevent trouble caused by stray pickup on the long lead.

The deflection-chassis power supply is controlled by a 6-volt relay. It has an extra set of contacts (normally closed) that ground the cathode of the picture tube when the set is turned off.

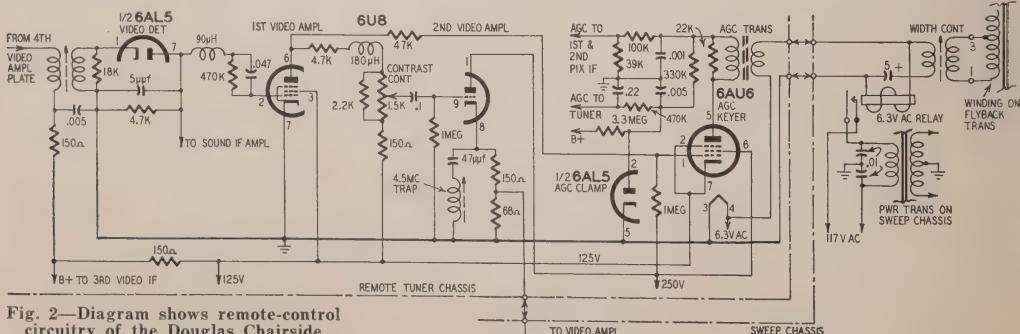


Fig. 2—Diagram shows remote-control circuitry of the Douglas Chairside

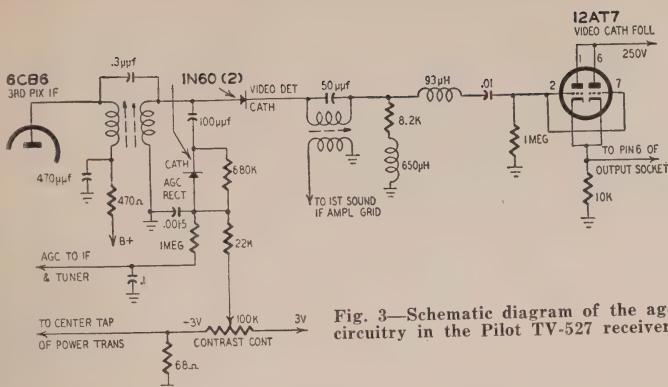


Fig. 3—Schematic diagram of the agc circuitry in the Pilot TV-527 receiver.

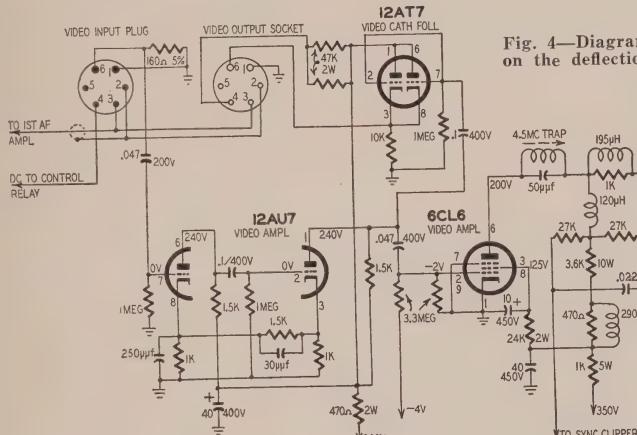


Fig. 4—Diagram of the video circuits on the deflection chassis of the Pilot.

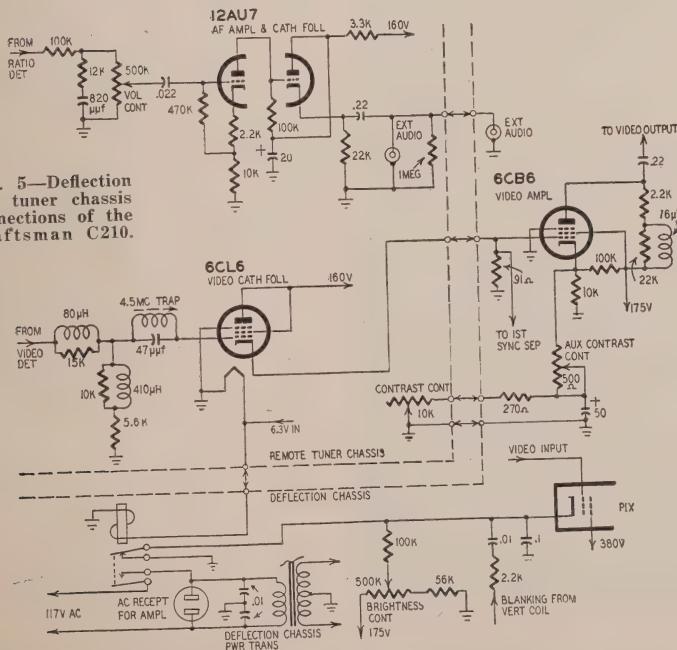


Fig. 5—Deflection and tuner chassis connections of the Craftsman C210.

This discharges the B-plus filter capacitors rapidly enough to prevent a bright undeflected spot.

Sylvania circuitry

The Sylvania remote-controlled TV receiver (chassis series 1-519) is the only one reviewed here that does not have the if circuits on the tuner chassis. The if output of the tuner is fed to a 6CB6 first video if amplifier over a coaxial cable. The signal appears across a 75-ohm grid resistor in the first if amplifier.

Fig. 6 shows the brightness and volume control circuits. To avoid running long audio signal leads from the tuner and main chassis and risking loss of highs and possible hum pickup, vol-

ume is controlled by varying the screen and plate voltages on the sound if limiter. Brightness is controlled by a 2-megohm potentiometer that varies the picture tube grid voltage.

As mentioned last month, the Pilot TV-527, Craftsman C210, Douglas Chairside and Sylvania 387-388 split-chassis sets have been discontinued and are discussed here for their informational value to service technicians.

Data has just been released on Zenith's ultrasonic Space Command and Motorola's transistorized radio-controlled circuit. We hope to cover these in an early issue.

END

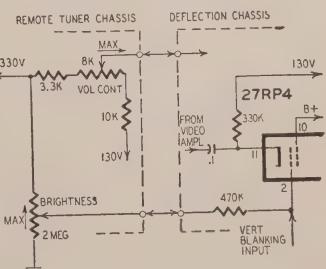


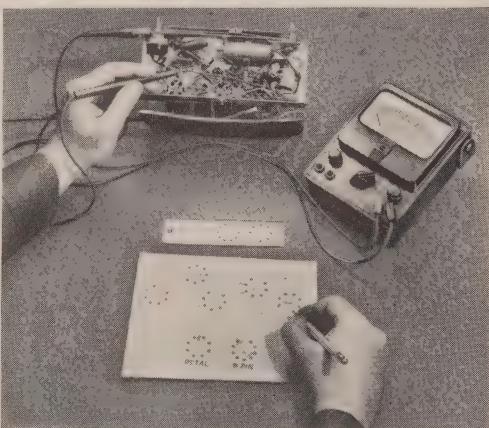
Fig. 6—The remote-control circuits in the Sylvania chassis series 1-519.

SERVICE SHOP TIME SAVERS

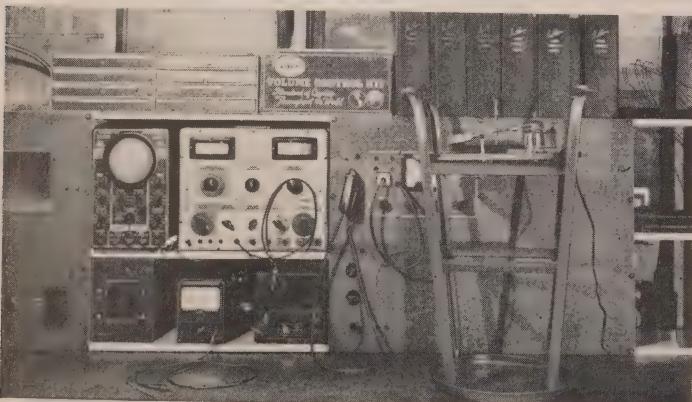
Hints for improving shop efficiency



Service bench layout keeps test equipment, service manuals and replacement parts stock close at hand.



A simple setup for speedy and accurate voltage measurements.



Handy rack with job cards and scratch pads increases efficiency in the shop.

By STANLEY L. KARAL

THE goal of all service shops is to trim service time to a minimum and thus reap a healthier profit. With this in mind several proven timesavers will be reviewed in the hope that they are just what you need to boost your shop efficiency.

Let us start where most service jobs start, at the telephone. If yours is a small shop and phone calls are taken by the bench man, considerable time can slip by while fumbling for a pencil, looking for a scratch pad or making like Sherlock Holmes to trace the status of a service job. This wasted time can be eliminated by using a file rack (see photo).

The rack holds all the job cards in four separate divisions, labeled from left to right: *Pickups and outside jobs, jobs in the shop for service, hold for parts and completed jobs*. Directly under the file are two scratch pads tacked to the file. One is for listing parts needed, the other for notes.

If the parts required to complete a job are not in stock, the job card is filed in the hold-for-parts file and the job number and the parts required are listed on the assigned scratch pad which serves as a continual reminder to order them. Two pencils are attached to the file rack with strong cord.

The rack shown is made for the usual three-piece service cards, consisting of guarantee tag, record card and claim check. Each piece is stamped with an identical number. When the job is brought into the shop—or picked up—the claim check is given to the

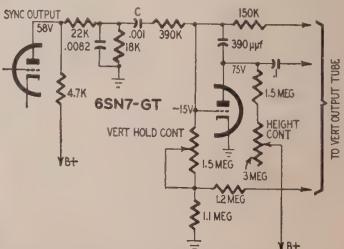


Fig. 1—Schematic diagram of the vertical oscillator in the RCA KCS82.

customer and the guarantee tag is attached to the set. The record card then goes to the back of the jobs-in-the-shop-for-service file. To work on the jobs in order, simply remove the record cards from the front of the file.

The most time-consuming place in the shop is the service bench. Keep handy a supply of screwdrivers, alignment tools, pliers and small socket wrenches. Always keep spare sets of these on hand; the time thus saved will more than pay for the tools.

Considerable time can also be saved by the general layout of the service bench. The photo shows an efficient layout for auto and home radio servicing. All test equipment is placed in an easy-to-reach cluster and all tools are removed from the work area.

The scope shown is used for tracing distortion in the audio section and it is used also to check the performance of vibrators and buffers in auto radio power supplies.

Directly under the scope is an adjustable isolation transformer which is used to isolate ac-dc chassis from the highline. It also serves to check portable radios for operation at low line voltages. To the right of the transformer is a dc supply for checking car radios. This voltage can be varied to catch slow starting vibrators, etc., by plugging the dc supply into the adjustable transformer.

The hand tools are housed in the drawers under the work surface of the bench and do not clutter the work space. The solder gun is mounted in a holster between the signal generator and the vtvmt.

Another time saver is the use of a bench stool for a spare changer rack. This is especially handy when the shop is swamped with changer jobs.

For maximum efficiency every technician should establish a set service routine and use it until it becomes second nature. One such well-proven procedure is first to isolate the faulty section and test the associated tubes, by substitution or tube tester. If this does not clear the trouble, measure the B voltages in the faulty section and compare them with the schematic. In most cases this will show the trouble

spot and ohmmeter checks will find the faulty component.

This is where a time saver—tube voltage guide (see photo)—comes in. The guide helps record the voltages in a readable manner. These data are then compared with the schematic and any differences investigated. The faulty component will show up quickly and without any of the false starts that usually go with hit-and-miss systems.

As an example, consider the case of Mr. B. A. Setfixer. He thumbed through the job file to find an easy one to finish off a particularly hectic day and he came to a set marked "dead vertical oscillator."

"This'll be a snap," he thought, hoisting the chassis onto the bench. He produced a schematic (Fig. 1) and laid it beside the set. As the set warmed up, a single horizontal line appeared. Delighted that the set was not intermittent, he took the voltmeter probe and "looked at" the plate voltage of the vertical oscillator tube.

"H'mmm, very little plate voltage . . . but the voltage is OK coming into the height control. The height control must be shorted to ground," his weary mind concluded.

He shut off the set and replaced the control. Another trial produced no raster and the voltage on the plate of the oscillator was still practically nil. Next our hero replaced the oscillator tube. Then anxious to see if the plate voltage had returned, he quickly touched the probe to the plate pin. It went high on the 250-volt scale.

"Doggone cheap tub-e-s . . . Hey! what gives here?" he exclaimed as the plate voltage slowly diminished to zero when the new tube heated up. Baffled, he checked voltages around the tube socket.

"What's this? 6 volts positive on the grid?" He finally stumbled onto the clue he needed — capacitor C was shorted.

The trouble is easy to explain now that we know the cause. The tube, with its high positive bias, looked like a direct short to ground to the high plate resistor (height control plus the 1.5-megohm resistor). Therefore the plate voltage was near zero.

Using this hit and miss system it took our hero over half an hour to clear

the trouble. Think of the time he could have saved had he used the voltage guide. The high bias would have shown itself immediately.

The guide is made from 1/16-inch Plexiglas. Two circles 1 inch in diameter are drawn on the protecting paper that comes attached to the plastic. One is divided into 8 equal parts, the other into 10. Each division mark is then pricked with a sharp center punch and holes drilled with a $\frac{1}{8}$ -inch center drill to the depth shown in Fig. 2.

Octal, octal and 7- and 9-pin tube bases can be quickly drawn with the guide. After you use this method a while it will take less than a minute per tube to draw the tube base and pick the necessary data from the chassis.

Much time is also wasted in parading to the tube shelves, removing the tube from the carton, substituting it, returning it to the carton and then taking it back to the shelves. This time can be cut to a fraction by keeping a supply of often-used tubes right at the bench, with those that are used continually kept out of their cartons.

This can be done with the tube carrier shown in Fig. 3. It holds uncartoned tubes in all of the current sizes plus a supply of cartoned tubes on the two shelves. Several of these carriers can be made, one for ac-dc radios, one for consoles and one for each of your most popular TV brands. Each space in the carrier should be marked for a certain tube type, making it easier to identify the tube needed or the tubes missing from the carrier.

Holes in the front row (for seven-pin miniatures) are $\frac{3}{16}$ inch in diameter and $1\frac{1}{8}$ inches deep. Those in the second row are $\frac{7}{16}$ inch in diameter and $1\frac{1}{8}$ inches deep for nine-pin miniatures. The two rear rows are $1\frac{1}{8}$ inches in diameter drilled clear through the piece for glass, GT and metal tubes. The lower shelves and lips are made from $\frac{1}{4}$ -inch plywood. The shelves may be set into dados as shown or fastened with brads and glue.

This by no means covers all of the time savers available to the service man, but it should be enough to orient your thoughts to time saving—and produce bigger profits.

END

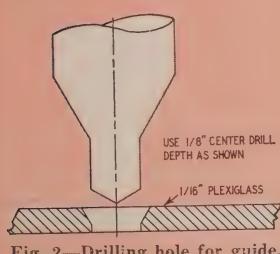


Fig. 2—Drilling hole for guide.

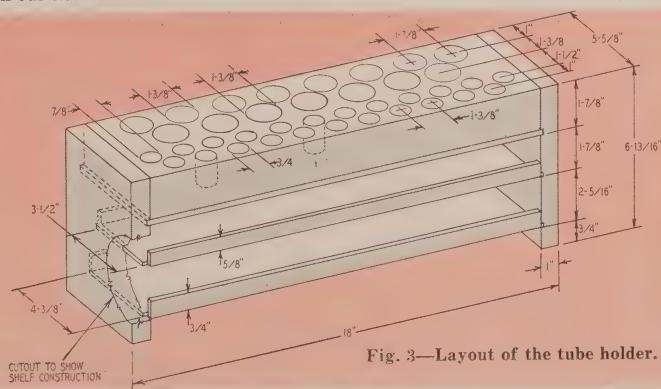
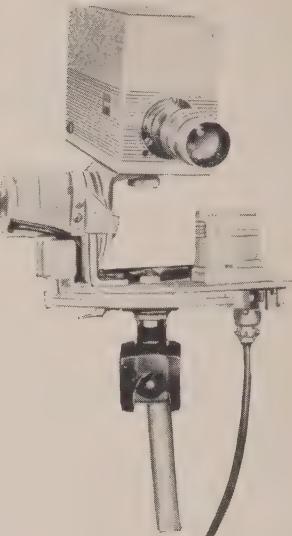


Fig. 3—Layout of the tube holder.

industrial**TV****techniques***Part IV—the camera circuitry*

By EDWARD M. NOLL



Typical industrial TV camera

In previous articles the pulse generator and its important coordination function in a closed-circuit television system were considered. This installment describes the camera arrangement of the Kay Lab industrial television system, model 1985A, taken as an example. It has three major units—camera, camera control and video monitor. The camera proper as shown at the left of the functional block diagram (Fig. 1) houses the Vidicon, a two-stage video amplifier and a cathode-follower output stage. A special protective circuit protects the Vidicon tube particularly in case of a sweep failure.

The camera control unit, which can be located at a convenient operating position hundreds of feet away, supplies all the operating voltages, pulses and deflection currents for the camera. It accepts the camera video signal, corrects it and inserts horizontal and vertical sync-blanking pulses. A composite video signal that can convey the picture information to a television monitor or viewer is thus formed in the camera control unit. The camera control unit and viewer can be adjacent to each other or separated, depending on the needs of the installation.

The camera proper

A number of signals and voltages are applied to the Vidicon camera tube, as shown in Fig. 2 (left side). Adjustable beam, target and focus operating voltages must be supplied to it.

These voltages are supplied from and controlled at the camera control unit, Fig. 1. Hence camera-tube adjustments can be made remotely. Variable control grid or beam voltage is supplied directly to pin 2 of the tube. Negative vertical blanking pulses also arrive over the same line from the camera control. (You will recall from previous discussions that it is necessary to blank a camera tube in the same manner as a television picture tube is blanked, so that no spurious signals are generated during retrace intervals.)

Horizontal blanking pulses are derived by shaping properly a signal taken from the horizontal deflection coil. This horizontal blanking arrives as a positive pulse via capacitor C603 at the cathode of the Vidicon.

Adjustable dc focus voltage is supplied through a decoupling filter (resistor R605 and capacitor C604) to the focusing electrode. Adjustable target voltage is likewise applied through a decoupling filter (capacitors C602 and C601 and resistor R602) and the output load resistor R601 to the signal electrode.

Video signal origination

The video signal is released at the signal electrode of the Vidicon camera tube, developing a black-positive video signal across load resistor R601. This signal is increased in amplitude by a two-stage video amplifier and is then matched to a low-impedance coaxial cable by a cathode-follower third video

stage. The two-stage amplifier is a cascode video amplifier which—as you know from TV tuner experience—has an excellent signal-to-noise ratio. Hence the very weak video signal is kept as noise-free as possible much as we minimize snow by using cascode tuners.

As you also know, a cathode follower is the impedance transformer of video circuits. The camera employs such a circuit to match the low-impedance cable (carrying video signal over a few hundred feet to the camera control unit) to the higher-impedance output of the cascode video amplifier.

Deflection

The deflection system of the camera consists of horizontal and vertical deflection coils, focus coil and two magnetized beam-centering rings. These components are assembled as a complete unit and fitted around the Vidicon tube. Horizontal deflection currents arrive via coaxial cable (pins 8 and 20). Vertical deflection energy arrives via a twisted pair and pins 6 and 18. Polarity reversing switches are provided at the deflection coils to provide mirror or inverted images when desired. Such an arrangement permits the camera to be mounted more conveniently in any position with the knowledge that an upright left-to-right image can always be obtained on the viewer.

An adjustable current arrives for the focus coil via pins 14 and 16. This coil provides an axial magnetic field along the length of the camera tube

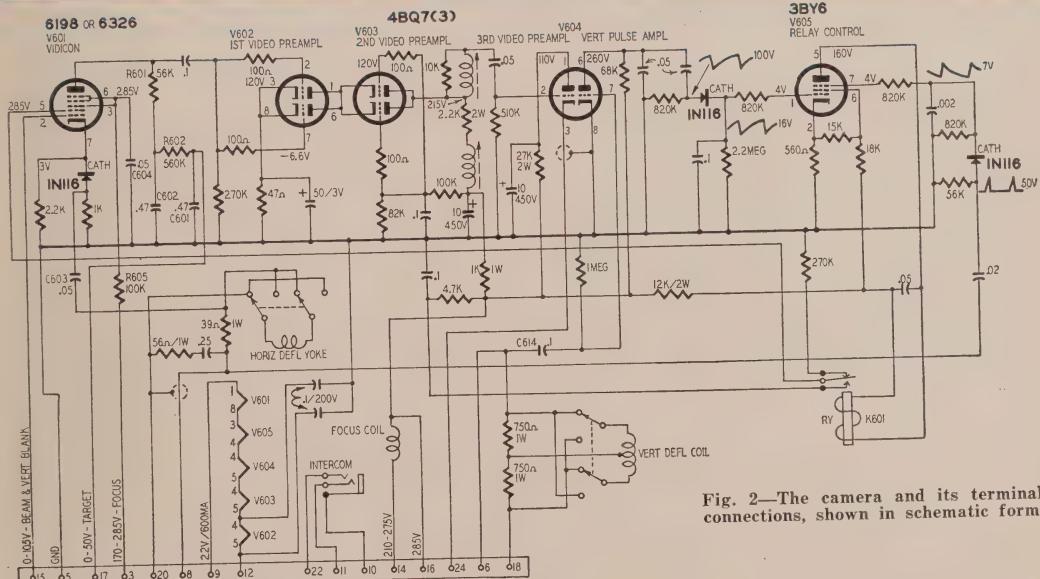
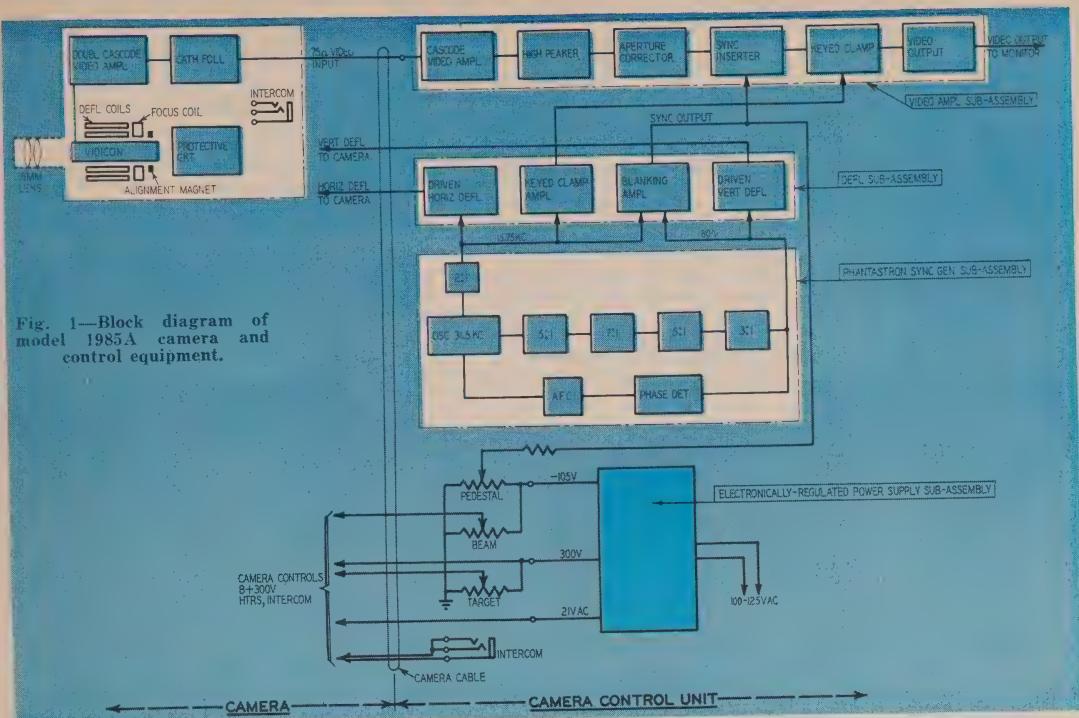


Fig. 2—The camera and its terminal connections, shown in schematic form.

to obtain true uniform focus of the beam.

A protective relay K601 makes beam current dependent on the presence of deflection currents. A pulse removed from the vertical coil is passed via capacitor C614 to the grid of V604. It is amplified, rectified and filtered to provide a positive sustaining bias at

grid 1 of V605. In the same manner a similarly derived pulse develops positive bias at grid 7 of V605. The two positive biases, when present, cause tube V605 to draw sufficient plate current through the relay coil to hold it energized. In so doing the relay contacts close and apply the necessary accelerating voltage to the camera tube.

If one or both of the deflection currents fail, the positive bias is lost at the relay control tube. Hence the relay is de-energized and its contacts connect a grounded resistor to the acceleration circuit. Thus beam current is shut off and target burning by a concentrated beam of electrons focused on a small area is prevented.

END



HOW well a television set is functioning can be determined readily from the picture on the screen and the quality of the audio from the loudspeaker. When either of these deteriorate, the technician, by analysis, can pretty much pin the trouble down to a very few stages.

As an aid in doing this, and in those cases where the trouble is difficult to isolate, the technician can take advantage of several tell-tale clues indicating receiver operation. These clues are dc voltages available at the many test points. The voltages at these points, while varying from set to set, are nevertheless signposts of what is happening in the set up to that point. In many cases these test points have been brought out by manufacturers to the top of the chassis.

Several of these dc voltages are produced by local generators in the set and thus do not vary significantly with signal strength. In fact, they exist with the antenna terminals shorted. These include the negative grid voltage of the rf, vertical and horizontal oscillators, and horizontal output tube, the boost or bootstrap voltage and the high voltage.

With a TV signal applied, other dc test points come into play to a greater or lesser extent. These include, depending upon the receiver, the voltage developed across the video detector load, on the agc bus, at the grid of the sync amplifier, at the limiter grid and across the ratio detector.

The above voltages will vary, not only with the set, but with the incoming signal strength and occasionally with control settings. Nevertheless, in most cases, a range can be established as representing a typical voltage. Experience with various sets will enable the technician to compress this range with different TV sets.

In considering typical voltages a signal strength equivalent to at least 6 mv from a signal generator must be applied. Preferably a stronger signal, in the order of 30 mv, should be used as a reference point.

The rf oscillator grid is an important dc check point where sound and picture are missing on all or even a single

channel. If a single typical voltage had to be selected for this point it would be -6. However, a great many sets work nicely with oscillator grid voltages as low as -3 and as high as -13. Unlike the vertical and horizontal oscillators, the rf oscillator does not operate at a single frequency. Varying from about 81 mc on channel 2 (21-mc if) to about 237 mc on channel 13, the oscillator will often vary as much as from -10 on the lowest to -5 volts on the highest channel.

For the vertical oscillator the type of circuit must be considered. The most popular is the blocking oscillator which produces a negative voltage on its grid of from about -10 to -40. There is sometimes a variation in this voltage due to the grid being connected to a hold control.

Most of the multivibrator type vertical oscillators will have about -10 to -30 volts on the grid of the section feeding the vertical output tube; practically zero on the input grid. Some vertical oscillators depending upon feedback from the vertical output tube (Fig. 1) develop widely varying voltages on their grid—as much as -65 or so as little as -8 volts.

The horizontal oscillator stage is pretty much dominated by the Syncroguide and multivibrator circuits. The grid of the horizontal oscillator in the Syncroguide setup is usually highly negative, an average reading being about -60 volts. Some sets will develop as little as -25 volts at this point, others as much as -80. The multivibrator circuit, usually cathode-coupled (Fig. 2), produces a much lower voltage. The input grid is generally close to zero or a volt or so negative, with the output-section grid measuring about -12 volts.

The hard-working horizontal output tube develops a grid bias usually about one-quarter of the peak-to-peak value of the driving grid voltage. A common average for this stage is about -25 volts. The variation from here is not too great, being seldom less than -15 or more than -35 volts. This voltage can be varied by the setting of the drive control.

The boost voltage varies considerably

and must be considered in relation to the B-plus voltage of the TV set. Assuming an average B-plus voltage of 275, we can assume an average boost voltage of at least 475. In older sets the boost voltage may be hardly more than 100 volts higher than B plus; in some of the newer sets it may be as much as 300 volts above.

Average high voltages cannot be listed since they will vary with the size and model of picture tube. A tube manual can be consulted for average operating high voltages for picture tubes.

Of the test points that develop a dc voltage in the presence of a signal only, the drop across the video detector load is most important as it is an excellent indication of signal strength. Most sets develop a signal of about 4 volts peak to peak at the video detector, with some as little as 2 volts and a few as much as 9. How much of this signal appears on the agc bus will depend upon the point of agc takeoff and the type of agc circuitry used. The negative voltage in simple agc circuits is usually not too much less than the voltage across the video detector load resistor. Of course, this relationship can vary considerably in keyed or amplified agc circuitry. Generally, the agc range from the weakest to strongest usable signal is from -0.25 to -6 volts.

The voltage developed at the limiter grid is a good indication of audio strength. With the gated-beam and ratio detectors and other new circuitry this point is becoming less reliable. However, in conventional limiter circuits a voltage of from approximately -0.5 to -2.5 can be expected.

The voltage on the grid of the input tube to the sync section will generally read something less than the peak voltage of the input signal. Thus, conventional sync amplifier or separator grid voltages are about -20. Voltages as low as -6 and as high as -30 are common.

The ratio detector is still another important test point. Fig. 3 shows a typical circuit. The voltages in parenthesis are signal-developed. The voltage across the stabilizing capacitor may vary from -5 to as much as -20.

A high-impedance voltmeter, preferably a vtvm, should be used in making these measurements. The above voltages are only typical. How efficiently these test points can be used depends upon the familiarity of the technician with a given set.

Devacuuming picture tubes

I have a window display in mind that contains a few picture tubes. It may be handled by my customers and I would like to make it as safe as possible. This means breaking the seal on the picture tube and letting air in. I have never attempted this but I heard that it could easily be done. My few experiences with broken or cracked picture tubes have left them unusable for display purposes.—R. T., Chicago, Ill.

The vacuum in a picture tube can be broken very easily and safely, but the procedure requires care and patience. Place the picture tube face down in a shipping or similar carton. Put enough soft packing material under the face so that the base of the tube extends through a small hole cut in the closed cover. See photo.

Now drill a $\frac{1}{4}$ -inch hole in the end of the locating lug on the base. An alternative to this is to break the lug off with a sharp blow or with a pair of pliers. Use a small file or cutting pliers and make a very small hole in the exhaust tip so air enters the tube slowly. Letting air in too fast may discolor the screen or make it flake. The silvery getter deposit on the neck will change color immediately.

A few minutes after the small hole has been made, the tip can be broken off completely. From here on in caution is limited to that of handling glassware.

Capacitor breakdown

An RCA chassis KC83 came in with no vertical sweep. After some searching I found a defective capacitor connected between plate and screen of the vertical output tube. I simply replaced this capacitor and the vertical sweep was perfect. Less than two weeks later I had a callback, and it was the same trouble.

I replaced the capacitor again and also replaced the 6K6 vertical output tube; all other components in this circuit checked good. I now have the set back with the same trouble and would like to know what the cause is. I can't face the customer on this again.—T. L., Kansas City, Mo.

In this case the trouble is very simple. The capacitor, a .001- μ f unit, is rated at 1,000 volts. It shunts the vertical output transformer and is thus subjected to extremely high sweep voltages. Replace this capacitor with a good-quality .001- μ f 1,600-volt unit.

15-ke whistle

Although I have noticed it on several Motorola receivers, customers have never complained of a high-pitched whistle. However, I have a Motorola now in which it is very loud and the owner objects. I have pinned it down to the horizontal output stage because it appears with the vertical oscillator out of the circuit and with the last if amplifier tube removed. It is no doubt the frequency of the horizontal oscillator. However, the best I can do is to vary the pitch slightly. I would like to know of some way to shield this interference.

Unfortunately, you did not state specifically the model number of the set. However, the question is of a general nature. The whistle you refer to is no doubt the 15,750-cycle horizontal sweep frequency. Basically, it is a mechanical vibration and so cannot be shielded in the usual sense—it could be caused by a loose turn of wire or some part of the

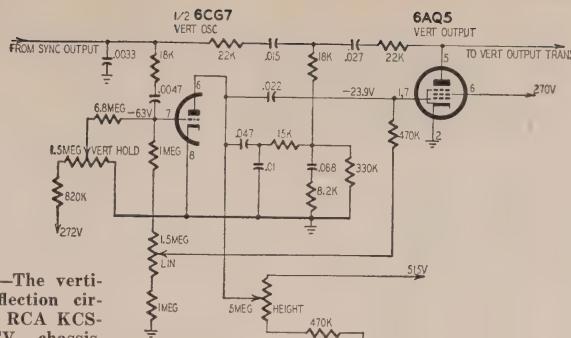


Fig. 1—The vertical deflection circuit in RCA KCS-103 TV chassis.

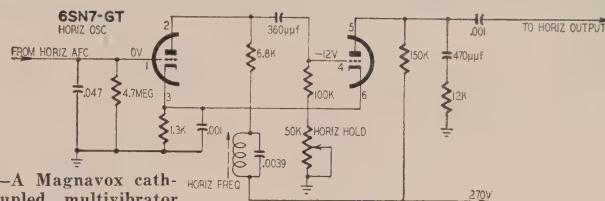


Fig. 2—A Magnavox cathode-coupled multivibrator from series 18 chassis.



Devacuuming picture tube. Tiny hole filed in exhaust tip lets air in slowly and sounds like leak in tire or a balloon.

horizontal circuit that is mechanically resonant to the sweep frequency. Fortunately it is outside the hearing range of most people. When it is not, it must be damped.

The most common sources of this trouble are the horizontal output tube and the flyback transformer. The tube solution is simple—replacement. In some horizontal output transformers you can adjust the width control slightly and eliminate the whistle. A more common solution is to pour high-voltage insulating compound between the core and windings of the flyback transformer. In some horizontal output transformers that do not use the variable air-gap type of core, the sound can be eliminated by slightly loosening or tightening the

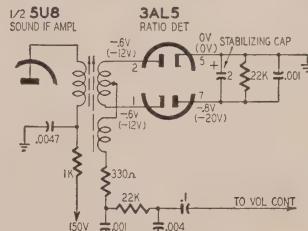
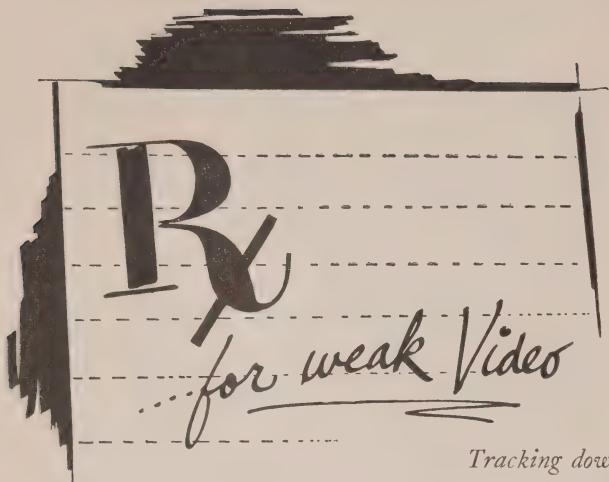


Fig. 3—Sylvania ratio-detector circuit with static and signal voltages.

core clamping screws. However, the powdered-iron core is fragile and breaks easily, so tighten gently. END



*Tracking down causes
of insufficient signal strength
in an important section of the receiver*

By CYRUS GLICKSTEIN*

WEAK video—a poor, low-contrast and possibly snowy picture—is a common TV complaint. In this article it is assumed that the weak video has occurred in a set which previously worked normally.

A weak picture may result suddenly from a component breakdown or gradually because of aging components. Weak video can originate in several sections of the set and may be caused by:

1. A fault in the video signal path (Fig. 1) between the antenna and picture tube.

2. A fault in a section supplying either control or operating voltage to any of the above circuits. These voltage-supplying circuits include the agc and low- and high-voltage power supplies.

3. A fault which does not affect either the video signal path or voltage sources yet produces the effect of weak video by reducing picture contrast or brightness. Examples of such miscellaneous faults are dust on the face of the C-R tube and safety glass and a weak ion-trap magnet.

Tracking down a fault to the defective stage and component is usually done in five main steps: a. noting all symptoms carefully; b. checking the action of pertinent controls; c. changing tubes; d. making key voltage, oscilloscope and similar checks; e. making voltage and resistance checks around the defective stage.

a. **Symptoms** Note if there is an accumulation of dust on the face of the

picture tube or inside the safety glass. Check the line voltage, especially if there are other symptoms in addition to weak video, such as a small raster, vertical roll, etc.

Note if there are any additional symptoms which may localize the trouble further, such as poor focus, low brightness, sweep distortion, poor sync, snow as well as weak video, etc. A weak picture with snow usually indicates a failure in the antenna, transmission line, rf amplifier or converter stage, or the agc circuit as it affects the rf amplifier. A weak picture without snow generally indicates trouble in some stage after the tuner.

b. **Controls** With the set tuned to an active channel, each of the following controls should be rotated through its range in approximately the order listed and the indications noted.

1. **Contrast control** There should be some variation of contrast as the control is rotated. If no variation is noticeable, check further in the contrast control circuit.

2. **Agc threshold control** If rotating the agc control has little or no effect in varying the contrast, this may indicate a fault in the agc line.

3. **Brightness control** If the brightness control at maximum fails to provide normal brightness, or at minimum fails to blank out the picture tube, but volume is normal, this points to the following possibilities: defective picture tube, misadjusted ion-trap magnet, defective high-voltage circuit, defective last video amplifier tube or circuit, a defect upsetting C-R tube bias, incorrect voltage to other C-R tube pins.

4. **Volume control** Low volume to-

gether with weak video may originate in a stage common to both video and sound signals (tuner, common if stage, etc.). However, if the volume seems normal, this does not completely rule out trouble in a common video-sound stage. A fault causing a reduction in both may still leave the sound at a fairly high level with weak video.

To check the operation of the complete sound signal path, turn the channel selector to a blank channel, turn the volume control to maximum and note if the normal rushing sound is heard from the speaker. If so, the fault causing the weak video is probably in the antenna-transmission line or one of the tuner stages; if not, the fault is in a stage after the tuner.

5. **Channel selector and fine tuning** If weak pix is evident on only one channel and other channels are normal, realign the oscillator coil for the affected channel. On occasion, an antenna-transmission line fault may show up on one channel only. If the weak pix is common to all channels and the fine tuning brings in a picture only at the extreme of rotation, this points to a need for a new oscillator tube, realignment of the oscillator coils, or both.

6. **Hold controls** Check if the sync action is defective by rotating both the vertical and horizontal hold controls and noting if the hold-in range is normal. If both controls act normally the fault is probably not actually weak video but some condition which simulates this fault (such as low brightness or dust on the C-R tube face). Poor hold action indicates weak video.

c. **Tube checks** If control adjustments do not eliminate the trouble, tubes should be changed in all sections that may be at fault. If the set has developed a weak picture over a period of time, one or more faulty tubes may be the cause. Substitute a new set in the tuner and check the result. If oscillator tube substitution improves the picture noticeably, but throws off the alignment, vary the overall oscillator adjustment or the individual oscillator coil adjustments as required for correct alignment. If the video is improved but still weak after tuner tube changes,

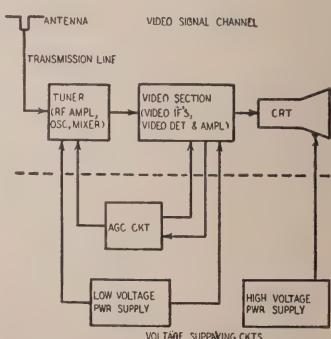


Fig. 1—The video signal path and circuits supplying voltages to it.

*Author of *Repairing Television Receivers* (John F. Rider Publisher, Inc.).

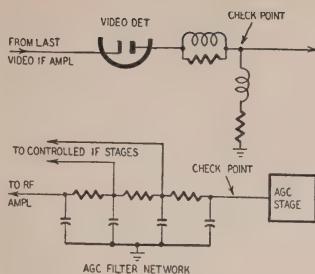


Fig. 2—Video detector and age voltage check points.

substitute new video if tubes. If necessary, try new video detector and amplifier tubes. Several new tubes in the video channel of an older set often work wonders in overcoming weak video and restoring peak performance.

To determine if any of the old tubes are usable, they may be replaced one by one and the effect on the picture noted. Old tubes which don't result in a weaker picture may be left in.

If the weak video developed suddenly, replace those tubes first which are most likely to be faulty on the basis of previous checks. If necessary, tubes should be changed in the tuner, video section (including agc circuit), low-voltage rectifier and any other circuit as indicated by the symptoms and control action. If a crystal-diode video detector is used, make a preliminary resistance check across the diode, measuring front-to-back and reverse resistance before any further troubleshooting.

d. Key checks If tube changes do not cure the fault, the next step is to make quick checks at the following key points to localize the trouble further:

1. Dc voltage checks at the video detector load and age line Dc voltage checks should be made at the video detector load and agc line (Fig. 2), first with the set tuned to an active channel, then with the set turned to an inactive channel.

With no signal applied (set turned to an inactive channel), the voltage at the video detector load should be a fraction of a volt negative. If a substantial negative voltage is measured with no signal, this points to regeneration in the video if stages and further checks are necessary in this circuit. With an incoming signal (set tuned to an active channel) the voltage at the video detector load should be -3 to -5. A reading of less than -2 volts indicates weak output between the antenna terminals and the video detector.

With no signal applied, the voltage on the age line should be practically zero. A positive voltage usually indicates a leaky coupling capacitor connected to one of the controlled if tube grids or a defective if tube.

With a normal signal the negative voltage on the if age bus should be -2 to -6, depending on signal strength. In some sets there are separate agc lines to the rf amplifier and

to the if stages. In such sets check both age lines.

A low age voltage (small negative reading) together with an abnormally high negative voltage at the video detector, with a signal tuned in, points to a fault in the age line which is responsible for the loss of age voltage and for the video overload. The high negative voltage at the video detector may bias the video amplifier so heavily that the video amplifier output to the picture tube is abnormally weak (Fig. 3). In the same way, low if age

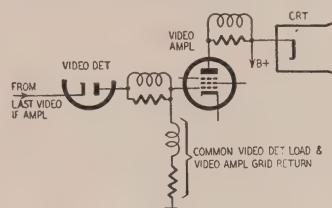


Fig. 3—A common video-detector output and amplifier-input circuit.

voltage, high rf age voltage and high video detector voltage may result not only in a weak picture but a snowy one because of the low amplification in the rf amplifier. This again points to a defect in the if age line such as a leaky or shorted age filter capacitor.

Servicing up to this point may be performed in the home. The following steps are usually taken in the shop:

2. Signal tracing with an oscilloscope In making bench checks for weak video, signal tracing with an oscilloscope is very effective. Check the waveform at the video detector load and measure the peak-to-peak voltage to determine if output at this point is below par (Fig. 4). Normally it is from 2.5 to 6 volts. Check the waveform at the plate of the last video amplifier, with the contrast control at the maximum clockwise position. The normal peak-to-peak voltage at this point is 40

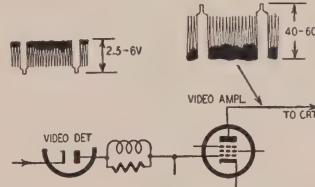


Fig. 4—Typical waveforms at the video amplifier grid and plate circuits.

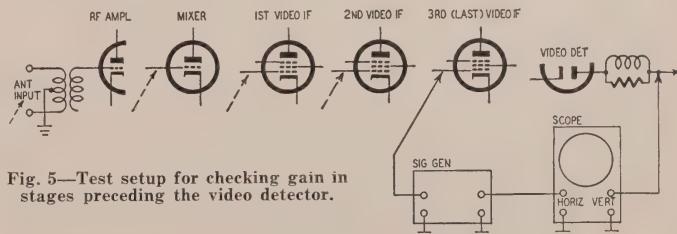


Fig. 5—Test setup for checking gain in stages preceding the video detector.

to 60. These checks quickly determine if the trouble is before or after the video detector stage.

3. Gain checks with a sweep signal generator and oscilloscope When a fault is located to the video section before the video detector, it can be further localized by gain checks with a sweep generator and oscilloscope. Turn set to a blank channel and disconnect the antenna lead-in from the antenna terminals. The scope is left at the detector load throughout the series of checks (Fig. 5).

With the sweep generator tuned to the intermediate frequency and with a 10-mc sweep, apply the output to the grid of the last video if stage. For this stage maximum generator output may be required. Set the scope at maximum vertical gain for the entire test. Note the amplitude of the signal on the scope screen. If it is large enough, turn the generator attenuator down so the least possible signal input is used.

Move the generator forward to the preceding video if grid and again note the output on the scope. A noticeable increase in waveform amplitude should be visible to indicate normal gain in the stage. A small increase or no increase indicates a defective stage. Repeat the process of turning down the generator gain and noting the amplitude before going on to the preceding grid. This prevents overloading an if stage which would result in a misleading indication of stage gain.

Then move the generator input to the preceding grid. Check each if stage this way in turn.

Check the front end, similarly, by turning the set to a given channel, again with the antenna disconnected. The sweep generator is set to the video carrier frequency of this channel. Generator output is applied to the mixer grid and antenna terminals, following the procedure described above. Performing these checks on several normal receivers will establish the usual amount of gain per stage.

Where misalignment is indicated, if and rf alignment should be checked with sweep and marker generators and oscilloscope according to manufacturer's specifications. However, most cases of weak video are not caused by misalignment. Partial or complete realignment may be required after replacing rf or if tuned-circuit components.

e. Voltage and resistance checks When previous checks have localized trouble to a particular stage, further

TELEVISION

voltage and resistance checks around this stage usually show up the defective part. In some cases, such as a change in capacitor value, substitution may be necessary to isolate the faulty component.

Common causes of weak video

In practically every stage which can cause weak video the fault may be produced by defective tube or by a drastic change of component value, such as a change in value of the plate, cathode or plate decoupling resistor or cathode,

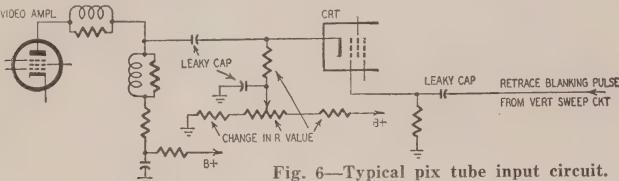


Fig. 6—Typical pix tube input circuit.

screen bypass, plate decoupling or coupling capacitor. The symptom may also arise if any capacitors are open or leaky. To avoid repetition, all trouble possibilities are not outlined for each section; only those most commonly found.

a. Antenna-transmission line Common causes of weak video resulting from antenna-transmission line troubles include: antenna rotated away from the optimum position for signal pickup; antenna partially shorting to some obstruction; corroded antenna connection terminals; partial or complete short across antenna terminals; break in transmission line; one or both transmission-line wires disconnected from the antenna or the receiver.

b. Front end Weak video may originate in any of the three front-end stages for the following reasons:

1. Low amplification in the rf amplifier stage. The signal-to-noise ratio is determined mainly by the strength of the video signal applied to the receiver input; gain of the rf amplifier; tube noise in this stage. A weak, snowy picture results from low video input to the rf amplifier (antenna-transmission line fault or poor signal area) or from a drop in signal amplification in the rf amplifier. (The fault may be in the rf stage or in the B-plus or agc line connected to this stage.) In some cases, a weak, snowy picture may result from a defective mixer with excessive tube noise.

Common rf amplifier faults include: defective tube; loose shield on rf amplifier tube; defective coupling capacitor from rf amplifier plate to mixer grid; change in value of cathode or plate resistor; faulty rf coils; detuned rf circuits requiring realignment; open or leaky bypass capacitors, especially in the screen or plate circuits; loose, dirty or corroded contacts on a turret tuner.

2. Low voltage output from the oscillator stage may be caused by: faulty oscillator tube; open grid-leak capacitor; detuned oscillator coil(s)

requiring realignment; open or leaky plate bypass capacitor; defective coupling capacitor from oscillator plate to mixer grid; change in value of plate resistor.

3. Low conversion transconductance in the mixer may be caused by: defective mixer tube; change in value of plate or cathode resistor; open or leaky plate bypass capacitor; defective coupling capacitor from mixer plate to grid of first if stage.

c. Video section Weak video caused by a video section defect commonly

changes; defective if coil; detuning; change in value of grid resistor.

4. Regeneration in if or video amplifier resulting from: open bypass capacitor; faulty lead or component dress; cold-solder ground connection; if tube shields missing or making poor contact with chassis; incorrect placement of peaking coils

d. Picture tube: A number of C-R tube faults produce symptoms which give the effect of weak video. These include: defective tube (low emission causes unfocused beam and poor definition); defect in tube focusing circuit or magnet assembly; incorrect voltage applied to screen grid or focusing electrode resulting in poor contrast; weak ion trap; defect or value change in cathode or grid circuit causing either abnormally low or high brightness on the screen (Fig. 6).

e. Agc circuit: Agc faults which can cause weak video include: defective agc rectifier amplifier tube or clamping diode; change of resistor or capacitor value in agc stage or bus; shorted or leaky capacitor in the agc bus; agc control incorrectly set; defect in agc control or associated circuit. In keyed agc circuits a defective keyer pulse coil may cause loss of agc (Fig. 7).

f. B-plus supply: A fault in the B-plus supply may result in incorrect voltage to one or more stages in the

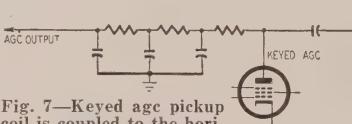


Fig. 7—Keyed agc pickup coil is coupled to the horizontal output transformer.

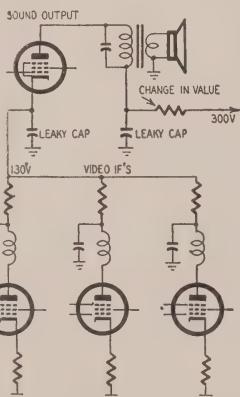
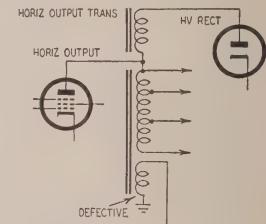


Fig. 8—B-plus path in series-tube set.

if coil; open peaking coil in video amplifier.

2. Abnormally low output from the video detector caused by: defective tube or crystal diode; open peaking coil; change in value of diode load resistor.

3. Incorrect bandpass in the video section caused by: component value

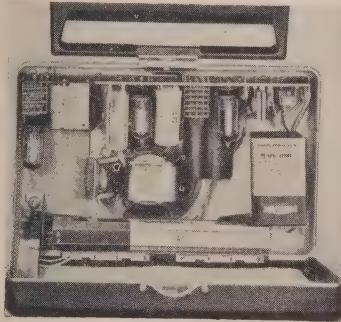
video channel and therefore cause weak video. Most common troubles are: defective low-voltage rectifier tube; defective filter capacitor; defective resistor or bypass capacitor in B-plus voltage-divider connections to the video section, front end, agc stage or picture tube. In some sets, a defect in the audio output stage may cause weak video where this stage is in series (B plus) with video if stages (Fig. 8).

g. High-voltage supply: A faulty high-voltage system can cause reduced high voltage, thereby causing low brightness, poor focus and a weak-appearing picture. This type of defect can usually be spotted quickly because of the inability of the brightness control to provide normal brightness at the maximum clockwise position. In addition, other symptoms are often present, such as a distorted raster, blanking of the picture and raster at maximum brightness control rotation, etc. Corona or arcing in the high-voltage circuit can cause noise in the picture which looks like excessive snow in weak signal areas.

END

MODULAR CONSTRUCTION

appears in home radios for the first time in the Motorola chassis HS-515, a portable. Modules have been used in television (Emerson) and test instruments (Du Mont). The components modularized in this circuit are the converter circuit, including the oscillator coil but excluding the rf output transformer, and most of the input and output components of the detector-ave-af stage. One interesting point that has puzzled technicians since modules have been announced—the list price of each of the "modular units" is \$2.85, per the service manual sheet.



WORLD'S FIRST UNDERWATER STUDIO

is this setup of WMOP, Ocala, Fla. Solely for publicity purposes, the studio was set up 15 feet below the surface of Florida's Silver Springs and broadcasts continued for over 13 hours. The "studio," only 8 x 8 feet in dimensions, contained a record player, two mikes and a line telephone. Biggest problem was getting the equipment into position without damage—solved by enclosing it in plastic bags for the trip to the "studio." The picture was taken just before signoff with the studio lighted by lamps above the tank.

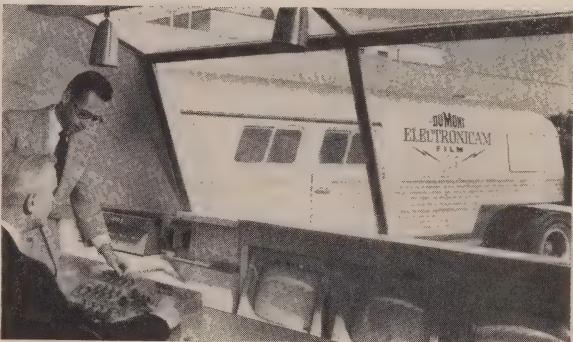
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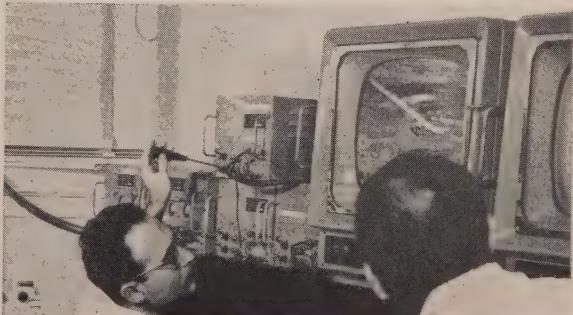
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MARRIAGE of electronics and Hollywood's traditional techniques was consummated with the leasing to Paramount of the Du-Mont Electronicam, a picture-taking setup which comes in two trailer trucks, one of which is intended to be wheeled right onto the sound stage. Essentially a standard moving-picture camera with an electronic viewfinder and a light sharing setup, the Electronicam system records pictures on high-quality film, delivers high-resolution pictures to viewfinders and as many monitors as desired and records a kinescope film with sound and supplies signals for recording on video tape.



AIRBORNE TELEVISION gives viewers a clear picture of the Pennsylvania Turnpike 50 miles away from the camera. The transmitting station is a helicopter whose cabin contains an FM transmitter of 100 watts ERP, an image orthicon camera, timing generator and high-gain antenna, dropped below the helicopter. The system was developed by Philco for the Navy Department's Bureau of Ships and is intended for control of amphibious landings and possibly in jet aircraft reconnaissance and other undisclosed applications.



UPSIDE-DOWN AMPLIFIER



Compact upside-down amplifier.

THIS little unit is a combination record player and hi-fi amplifier.

The photos show a Garrard model

T manual player and 10-watt amplifier built into a single cabinet no larger than the base used with the turntable alone.

This compactness is made possible by building the amplifier *upside down* on a standard 8 x 12 x 3-inch aluminum chassis. The turntable motorboard mounts above the chassis so that the phono motor and turntable bearing projects down into the innards of the amplifier. Components and wiring are arranged so that space is left for the mechanical assembly and the two units are then sandwiched together.

The power transformer and tube sockets are mounted on the rear of the chassis along with signal jacks and ventilating holes. Controls and preamp assembly are arranged along the front edge and the output transformer uses the remaining space available in front of the phono motor.

Obtain all components first, then *very carefully* decide exactly where the turntable assembly is to be mounted and what position the chassis will occupy with regard to the mechanical unit. Then measure precisely where mechanical parts project into the chassis and how much space they will require. When you are sure that you have al-

lowed sufficient space in the amplifier chassis for the phonograph motor and associated parts, lay out the amplifier components and wiring to make the best use of the space left.

The unit shown uses Knight (Allied Radio) S-234 10-watt amplifier kit with the addition of a few parts. The schematic diagram (Fig. 1) indicates by large dots parts not furnished with the kit. The mixer and preamp circuits within the dashed lines are also extra parts. A few changes were made in the original amplifier circuit to increase stability and extend frequency response. The preamp and mixer sections were added to give correct equalization for a wide-range crystal phono cartridge and provide for a radio tuner without extra switching.

Because the power transformer is necessarily located close to the phono pickup, magnetic cartridges simply will not do. Unless you want to mount the power transformer at the end of a 10-foot cable, the only solution is to use one of the new wide-range crystal pickups. I selected the Ronette TO-284-P which combines the virtues of smooth frequency response with extremely low intermodulation distortion.

The Ronette is fed into a 220,000-ohm load to attenuate response below 50 cycles. The .03- μ f coupling capacitor in the plate circuit of the first stage was

Unusual arrangement has amplifier built around record player

By GEORGE L. AUGSPURGER

chosen for the same purpose. If the cartridge works into a load of 1 meg-ohm or greater, it picks up all sorts of subsonic pulses from the turntable which easily overdrive small speaker systems. Since (contrary to advertisements you may read) *no* bookshelf speaker puts out any sort of usable response below 50 cycles, it seems silly to use amplifier power just to burble the speaker cone back and forth. Such low-frequency pulses can cause considerable distortion by driving both amplifier and speaker into nonlinear operation.

The response curve of the Ronette shows a very gentle rise to about 5 kc and then a gradual slope to about 10 kc. High-frequency losses in the mixer circuit smooth out the high-frequency peak, and the .004- μ f bypass capacitor in the 6SC7 cathode circuit reinforces the drop above 5,000 cycles to give a very close approximation to the RIAA curve.

Output voltage from the Ronette cartridge is enough to drive the amplifier without the 6SC7 preamplifier stage, but phono-radio isolating resistors and balance control drop the gain enough to make the extra tube desirable. It would be easier just to include a "phono-radio" switch on the front panel but the system was designed to be as simple to operate as possible: To play the phonograph turn the amplifier on and put a record on the table; to hear the radio switch on both tuner and amplifier, and there you are.

A balance control is included in the phono preamp so that radio and record player loudness can be adjusted to the same level. If a compensated loudness control (such as the Centralab Cl-70-S Compentrol) is used for the main volume control, the balance control can be used to adjust the maximum level and, therefore, the amount of loudness compensation at normal listening level.

The two-channel mixing circuit attenuates high frequencies somewhat.

R1—220,000 ohms
 R2—3,300 ohms
 R3—100,000 ohms
 R4—33,000 ohms
 R5—100,000-ohm pot
 R6—100,000 ohms
 R7—100,000 ohms
 R8—100,000 ohms
 R9—2,700 ohms
 R10—270,000 ohms
 R11—1-megohm pot
 R12—22,000 ohms
 R13—1-megohm pot
 R14—1-megohm pot
 R15—270,000 ohms
 R16—4,700 ohms
 R17—47,000 ohms
 R18—1 megohm
 R19—100,000 ohms

Part No. & Description		Value	Notes
R20— <u>I</u> , 1,500 ohms		C6—.09 μ	
R21—33,000 ohms		C8—250 μ uf	
R22—33,000 ohms		C9—.009 μ	
R23—7,500 ohms		C10—.001 μ	
R24—220,000 ohms		C11—.08 μ	
R25—220,000 ohms		C12—.05 μ	
R26—300,000 ohms		C13—270 μ uf	
R27—50-ohm pot, 2 watts		C14—.01 μ	
R28—15,000 ohms, 1 watt		C15—40 μ f, 450 volts	
R29—2,200 ohms, 2 watts		C16—50—80 μ f, 475 volts	
R30—250 ohms, 5 watts		All capacitors 600 volts unless otherwise noted	
All resistors $\frac{1}{2}$ watt unless otherwise noted			wise noted
C1—.004 μ		V1—6SC7	
C2—.03 μ		V2—6SN7-GT	
C3—20—10, 50 μ f, 450—450, 50 volts, electrolytic		V3—6SN7-GT	
C4—.02 μ		V4—6V6-GT	
C5—.002 μ		V5—6V6-GT	

V6—5Y3-GT
 5-spst switch on volume control
T1—output transformer for push-pull
 6½ x 10, 1000 ohms plate-to-plate,
 10 watts
T2 power transformer, 760 volts ct @
 12½ ma, 6.3 volts @ 3 amps,
 5 watts @ 2 amps
Octal sockets (6)
 Pilot light and assembly
Input jacks (2)
Output jack
 Line cord
Knobs (3)
 Chassis, about 18 x 12 x 3 inches
 Record player
 Cabinet for record player and
 amplifier

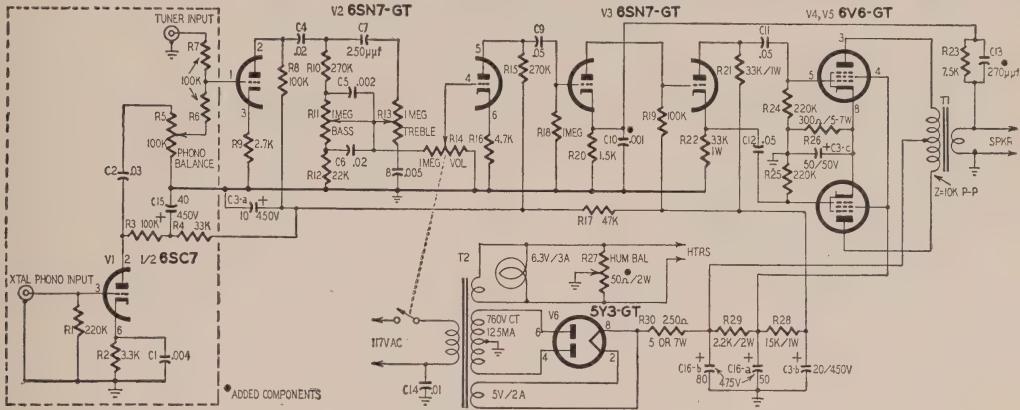
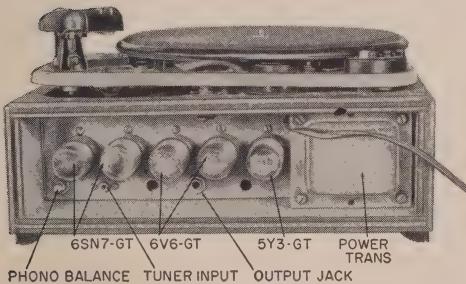


Fig. 1—Schematic diagram of the upside-down unit—fundamentally the Knight 10-watt high-fidelity amplifier.



Rear view of the amplifier

Amplifier components are arranged to fit around underside assembly of the phonograph record player.

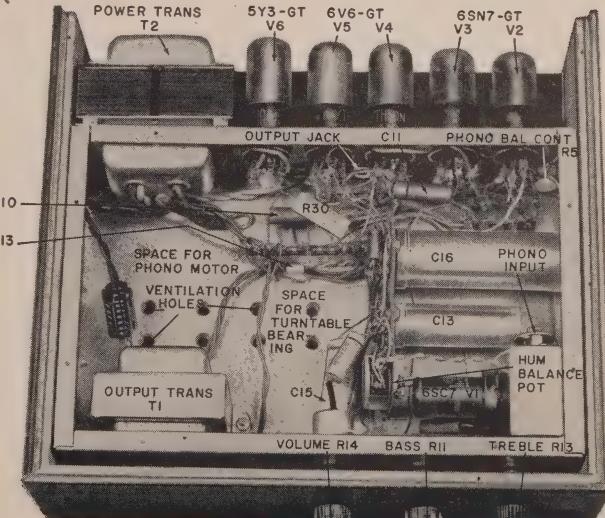
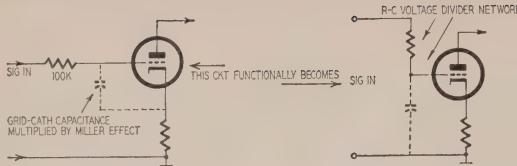


Fig. 2—How high frequencies are lost in mixer circuit.



The Miller effect increases interelectrode capacitance between the first 6SN7 grid and ground. This capacitance, together with the 100,000-ohm isolation resistors, forms a high-frequency shunt circuit (Fig. 2). Additional treble losses are introduced when the 1-megohm volume control is near mid-setting.

Fortunately, the .001- μ F capacitor in the main feedback loop not only stabilizes the high-frequency response of the amplifier but compensates for the loss of highs in preceding stages. The value of this capacitor can be changed to compensate for wiring layouts, transformers variations or circuit changes. Once the response curve of the amplifier has been flattened, however, check for high-frequency instability.

All inexpensive feedback amplifiers, such as the Knight or Heathkit A-7D, have a tendency to ring when overdriven. This can be observed by running about 60 cycles into the amplifier and watching the output on a scope while the system is connected to a speaker load. Crank up the input signal until clipping is visible. If somewhere in the process a fuzzy shape (Fig. 3) appears on part of the waveform, it indicates high-frequency instability.



Fig. 3—Oscilloscope pattern shows ringing as amplifier is overdriven.

Changing the values of C10 and C13 will get rid of the ring but will also change the amplifier response curve. A small capacitor of 50 to 250 μ F across the phase-inverter plate resistor will often eliminate instability without seriously changing characteristics.

The Knight kit, as furnished, also has a positive feedback loop to increase sensitivity, but it was impossible to retain this circuit and still keep the amplifier stable under all load conditions. Since the amplifier has plenty of gain as diagrammed, there is no reason to worry about loss of positive feedback.

Juggling capacitors and feedback loops, as mentioned, is necessary only if you are a perfectionist and have the necessary equipment. The amplifier will sound good if the diagram is followed exactly. Hum is a different sort of problem—it is something you can hear and consequently worth while getting rid of. The 50-ohm 2-watt hum-balancing pot and .01- μ F capacitor from the ac line to chassis ground are both added

to keep hum below audibility.

The balancing pot is a feature found in most commercial hi-fi amplifiers. The idea is that, by shifting the ground point of the filament system, a null can be found where hum introduced in the heater circuit cancels hum voltage picked up from other sources. Although this scheme lowers the hum level of the amplifier to insignificance if good wiring practice is followed, the input circuit is still sensitive to body capacitance unless the chassis is grounded. And most people don't have ground wires available for small record players.

Nonmetallic tone arms, such as that on the model T, provide no shielding

for the pickup wires at the point where you handle the arm to put it on a record. Every time you put your fingers on the pickup head an annoying loud buzz is heard. A small capacitor from one side of the ac line to the chassis will stop this nuisance so long as the line plug is inserted the right way.

Any small amplifier circuit can easily be adapted to the upside-down type of construction. The Knight circuit described or the Heathkit mentioned are both excellent low-power amplifiers for small systems. The builder will find that one of these or a similar kit plus the additional chassis and other parts cost considerably less than purchasing individual components.

The cabinet can be made like the one shown here or designed to fit any standard manual player or record-changer assembly. Most companies furnish mounting templates with their phono units so that chassis and cabinet can be accurately laid out beforehand. If you don't have the tools or skill, any local cabinetmaker can do the job. END

BALANCING THE GOLDEN EAR

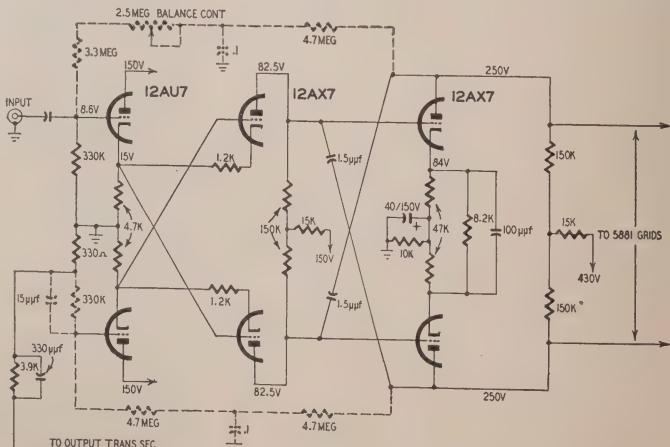
The long-term stability of the direct-coupled front end in Mr. Marshall's Golden Ear amplifiers is poor because of the severe requirements which it places on the stability of the B-plus and heater-voltage supplies. Since the B-plus supply to the inverter stage is regulated by a voltage-regulator tube, the primary cause of balance drift is probably line-voltage variations. For a particular 12AU7 selected at random, the cathode-to-cathode voltage of the cathode-follower input stage varies about .038 volt as the line voltage is varied from 105 to 125, with plates held at 150 volts.

This modification improves the balance and minimizes drift by applying negative feedback from the driver plates to the grids of the input stage as shown in dashed lines. To maintain gain within the loop, the feedback paths are designed as low-pass net-

works with the 3-db point at .04 cycle. For the values shown, the feedback amounts to around 27 db. The proper balance point is reached by controlling the resistance in one of the feedback legs with a variable resistor. The 330,000-ohm grid resistor for the lower half of the 12AU7 is shunted by 15 μ F for 90% compensation of the grid-to-plate capacitance.

No claim is made for originality in this design, although I have not seen a comparable feedback circuit described anywhere.—Joseph J. Conradi

(Mr. Marshall reports that this modification works fine and produces a very stable amplifier. He adds however that it is simpler and no more expensive to add another 150-volt voltage-regulator series with the one already in the Golden Ear amplifiers and apply 300 volts regulated to the driver—Editor)



Stereo Tape Comes of Age

Theory, tape and equipment for the latest in audio realism

By HERMAN BURSTEIN

It is virtually a matter of months since tape equipment has become a significant member of the high-fidelity family. Though there are perhaps two million tape recorders in American homes, yet the vast majority have been employed as novelties rather than to record and reproduce music with anything like fidelity. But during the past year the home tape player has at last made substantial headway. Today some 30 labels of prerecorded tape offer various types of music, certainly an indication that tape is finally coming into its own.

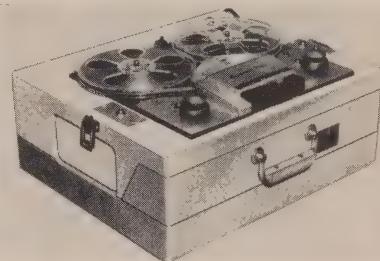
With monaural tape just acquiring a firm foothold in the high-fidelity realm, stereophonic tape is but a step behind. So short is the step that it is hard to remember the infant of two or three years ago, to be heard only at audio fairs, a few sound salons and other select places. Although it still has a long way to go, nevertheless it may fairly be said that stereo tape has come of age. A year or so ago the audiophile who wanted to play around with stereo was thrown largely on his own resources unless he could afford one of the few and expensive pieces of equipment then available. Today he is in a position to choose from a variety of stereo tape products at prices suiting any pocketbook. Monthly his choices increase.

When we consider that much has been made of three-dimensional listening only within the last few years (outside of a few path beaters like the motion picture *Fantasia* which appeared in 1941), it is interesting to note that stereophonic reproduction goes back at least as far as 1933. At the Chicago World's Fair that year a binaural system was demonstrated



Educational Labs
M-7 stereo recorder.

The portable stereo recorder made by the Amplifier Corporation of America.



which employed earphones. Later that year Bell Laboratories presented a three-channel system using speakers instead. There are even earlier reports of experiments carried on by broadcast stations on two channels, on which I can get no details at the moment. These early experiments were limited to simultaneous production and reproduction of sound because the existing media for audio recording did not permit preservation of the exact phase (time) relationship between pickup of the sound by each microphone.

The advent of tape recording provided a ready means for recording two separate sources of sound in their original phase relationship. Shortly after World War II, experiments along this line were conducted by personnel of the Armour Research Foundation. Then followed the practical adaptation of these findings first by one or two tape-recorder manufacturers and subsequently by a considerable number.

Stereo vs binaural

Three-dimensional sound on tape, feasible for the home, initially took the form of *binaural* reproduction, requiring earphones in playback. This system employs two microphones spaced about 8 inches apart—equivalent to the distance between a human's ears—and separated by a sound-absorbent material. The dual microphone setup is positioned in such a spot as a listener might occupy for favorable results. Sound picked up by one microphone is recorded on the lower track of the tape and sound from the other on the upper track. In playback, the signals from each track are separately amplified and fed to the listener's left and

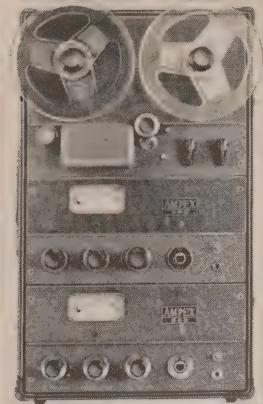
right ears. In short, the tape recorder is a time-delay device which places the listener's ears at the original performance.

Although binaural reproduction has pronounced advantages for industrial use, such as analyzing machinery performance, it became apparent that sustained listening to music through headphones, while marvelously realistic, is a downright nuisance for most persons. Therefore the sound from binaural tape was funneled through speakers instead. But the remarkable illusion gained through headphones no longer existed when speakers were substituted.

However, it was found that a good deal of the illusion could be regained by proper placement of microphones and speakers. Stereo reproduction through speakers, although still not as realistic as through headphones, has improved to the point that—weighing comfort against realism—stereo is preferable. Consequently, practically all the three-dimensional tapes made today are produced on a stereo basis; that is, the microphones are several feet rather than a few inches apart. It is to be expected that further advances in microphone technique and speaker location will continue to lessen the difference between binaural and stereophonic reproduction.

Stereo systems

Stereo reproduction (via speakers) is based on the "curtain-of-sound" theory. It assumes a soundproof curtain between the original source, say an orchestra, and the listener. This curtain is punctured—in monaural listening—by the single microphone on the stage and the single speaker in the listener's

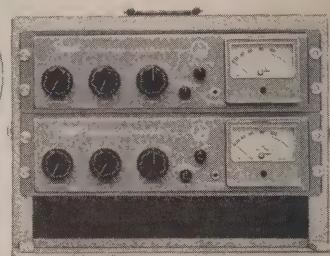


Above, the Ampex S-5290 stereo recorder. Above right, Educational Laboratories model M-6A. Right, the Berlant-Concertone model 33-2 stereo recorder.



are considered. Dual preamplifier-amplifier combinations, all on one chassis, that are less than double the price of their monaural counterparts are available. If the user needs only add an additional amplifier to accommodate the second channel, he can do quite nicely with a unit of moderate power, say 10 watts, not only because the total power requirements are now divided between two channels, but also because music at a substantially lower level will provide the same sensation of sound filling the room as does a monaural system operated at high power.

So far as speakers are concerned,



living room, giving rise to the so-called "hole-in-the-wall" type of reproduction. Hypothetically, for the curtain-of-sound effect, on the far side of the curtain is a line of microphones, while on the listener's side is an equal number of speakers. Each microphone is linked through an amplifier to the speaker directly opposite it. Thus each microphone-speaker combination constitutes a channel for penetrating the sound-proof curtain. By inserting a tape recorder between each microphone and speaker, one introduces a time delay which permits the listener to hear the orchestra at a later time and at another site; the orchestra is brought into his own room.

While the curtain-of-sound theory does not operate perfectly because each microphone cannot be confined to an exact area, nevertheless it performs very well in practice. The number of transmission channels required to complete the stereophonic illusion ranges from four to six, depending upon the nature of the sound source. Experience has shown that a lesser number of channels can closely approach the stereophonic effect. A two-channel system is a major advance over a monaural (one speaker or two speakers fed from one channel) system. Another major step is achieved by a three-channel system, which is often considered to be optimum. Further increase in number of channels adds relatively little or nothing to the stereophonic sensation.

For economic and technical reasons, present stereo tape equipment intended for the home is two-channel although at least one company (Ampex) makes a professional three-channel machine with a price tag around \$2,500. As previously indicated, a two-

channel system can go a long way toward imparting the illusion of a three-dimensional source.

Two-channel stereo tapes require that the two microphones be spaced between 6 and 20 feet apart, depending on the sound source. Usually, the spacing is between 6 and 12 feet. The reproducing speakers should be similarly spaced if possible. It is recommended that both speakers be in line with each other so that their axes are parallel, as shown in Fig. 1-a, not turned in, as Fig. 1-b, so that their axes converge. Fig. 1-a corresponds to the curtain-of-sound principle previously described. Thus the stereophonic

it has been observed that a stereophonic system makes considerably smaller demands than does a monaural system for the same degree of satisfaction. True, it would still be nice to have the best that money can buy. However, one is apt to find much less difference between relatively small and inexpensive speaker systems and their expensive brethren when using a stereo system than when reproducing monaurally. It has also been observed that stereo systems are more tolerant of limited frequency range and distortion.

On the other hand, it is felt in some quarters that ideal stereo results call for speakers with frequency response characteristics carefully matched to preserve the correct amplitude relationship between channels.

In-line vs. staggered heads

The stereo effect depends upon several acoustic phenomena, one of which is a difference in frequencies picked up by each microphone—"violins on the left, bass on the right"; another is difference in amplitude; a third is difference in phase of the same sound picked up by each microphone. Substantial importance is attributed to phase differences.

If the playback heads for each channel are not spaced exactly the same distance apart as in recording, the phase relationship between channels is altered. A number of authorities feel that it is therefore vital to preserve precisely the same spacing between heads in playback as in record. To this end the so-called *in-line* head has been developed. It consists of two individual heads constructed as a single unit so that the gap of one is vertically in line with the other. To align the two

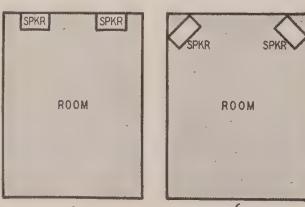


Fig. 1—Speaker placement at *a* is preferred to the toed-in arrangement at *b*. Illusion is preserved (more or less) in virtually any part of the room when the speakers are as in 1-a whereas the placement in 1-b causes the listener's position to be more critical for satisfactory results. Some authorities disagree as to the rigidity of this rule, and the listener may well experiment with speaker placement.

Although a stereo system apparently calls for doubling the audiophile's paraphernalia so far as control units, power amplifiers, speakers, etc. are concerned, this is not true when cost and space

gaps exactly is no small feat, so one in-line head at present often costs more than two equivalent single-gap heads.

In part because of cost, some manufacturers are using staggered heads, which are spaced 1.25 inches apart. Some authorities claim that gap spacing must be preserved with an accuracy on the order of .0001 inch (well-nigh impossible with staggered heads); others claim that in practice the spacing can be varied considerably before the ear detects a difference. Moreover, they believe, if a difference is detected, it does not necessarily follow that the stereophonic effect is less profound than it otherwise might have been. It is different, but not necessarily inferior.

From the viewpoint of fostering the stereophonic sensation, the battle of in-line vs staggered heads is still to be won decisively, although the trend appears to be toward in line. As a general rule, the more expensive machines use in-line heads, but some moderately priced units incorporate them as well.

In-line heads have at least two advantages apart from preservation of phase relationship. Mechanical positioning of a single in-line head with respect to the tape is simpler than alignment of two heads. A second important advantage is that editing is far simpler. Staggered heads pose the problem of cutting splices in staggered fashion to avoid detection.

On the other hand, the staggered-head system is—at least up to now—less costly and has the advantage of no cross-talk. There is mutual coupling between each section of an in-line head—each section, through induction, detects some of the signal picked up by the other section. Although the cross-coupled signal from the opposite channel is usually at least 35 to 40 db down, this nevertheless presents certain difficulties. If the head is used to play a stereo tape, some reproduction of channel A by head B and vice versa is not noticeable because, after all, both channels are reproducing the same material. However, if one section of an in-line head is to play track A of a dual-track monaural tape, then the unused section will pick up the signal from track B, transferring some of this signal to the first section. Even though the signal from track B is 40 db down, it can be quite disturbing during quiet passages of track A. Consequently, at least one of the machines with in-line heads uses an additional single-gap head for playing monaural dual-track tapes.

Commercial equipment

This section describes products already available or shortly to appear on the market and intended principally for home use in connection with recording and/or playing stereophonic tape. The author has tried to contact all tape-recorder manufacturers listed, to ascertain what stereo equipment is

being made. Such omissions as may occur are therefore entirely inadvertent. Prices have been included wherever obtainable. Note that these are highly approximate and are given chiefly to show ratios of cost between one piece of equipment and another. Prices vary too greatly with time, geographical location and dealer audiophile policies to make it possible to come very close to the actual price at any given point some months after the article is written.

Stereo tape equipment presently or soon to be available offers the audiophile a great deal of choice in setting up a stereo system. He can purchase a unit which permits stereo recording as well as playback; he can purchase playback equipment only; he can purchase a complete stereo system inclusive of power amplifiers and speakers; he can purchase individual components intended for stereo use, such as tape transports, preamps, power amplifiers, heads, speakers, etc.

All the equipment discussed below is designed to operate at 7.5 inches per second. Most are designed to operate at 3.75 ips as well. Some offer the option of other speeds, such as 15 ips. In virtually all cases, the NARTB equalization characteristic is followed.

Record-playback units

Record-playback stereo machines now available include those of Ampex, Concertone, Amplifier Corporation of America and Educational Laboratories. Reference here is to an ensemble containing a transport mechanism and matched preamplifiers, with no assembly or adaptation of one unit to another required.

The Ampex stereo recorder, model S-5290 is available on special order. Except for the in-line heads, this model has the same components as the familiar monaural model 601 (formerly the 600, which had a high-impedance output). The tape transport is the same and so are the record-playback preamplifiers, two of which are used. However one of the preamplifiers contains no oscillator, means being provided for feeding bias and erase currents to both channels from the oscillator in the "master" preamplifier. Price of the S-5290 is \$950 for the chassis alone and \$995 in a portable case.

Ampex manufactures a companion amplifier-speaker combination, model 620, available in a portable case or in a "furniture" version at \$169.50 (blond \$10 additional). Model 620 contains equalization to compensate the frequency characteristics of the speaker in its enclosure so that the amplifier-speaker combination is substantially flat over an extended range. Altogether, a complete Ampex stereo system may be had at a cost of about \$1,335.

Berlant-Concertone produces a stereo recorder in both its series 20 and series 30 lines. (The essential differences between the two are that the latter employs better motors in the transport and is manufactured under conditions

of more rigid quality control and parts tolerances. The series 30 line costs \$200 more.) Model 23 is priced at \$795 and model 33 at \$995; this includes transport and two preamplifiers, without enclosures. Model 33-2 is housed in two portable enclosures costing \$120 additional. In the Berlant-Concertone units, each preamplifier has its own oscillator, the two being operated in synchronization to avoid beat frequencies. The company has introduced a variety of conversion kits which permit its monaural machines to be converted into stereo units either for playback only or for record as well as the playback function.

An amplifier-speaker combination is produced by Berlant-Concertone. Part No. 105250, priced at \$150, is housed in a portable enclosure, and Part No. 105251, priced at \$195, comes in a wood cabinet. Each cabinet also provides room for one preamplifier. Thus a complete system, including power amplifiers and speakers, would cost a minimum of \$1,155 (series 20, portable enclosures) and a maximum of \$1,460 (series 30, wood cabinets).

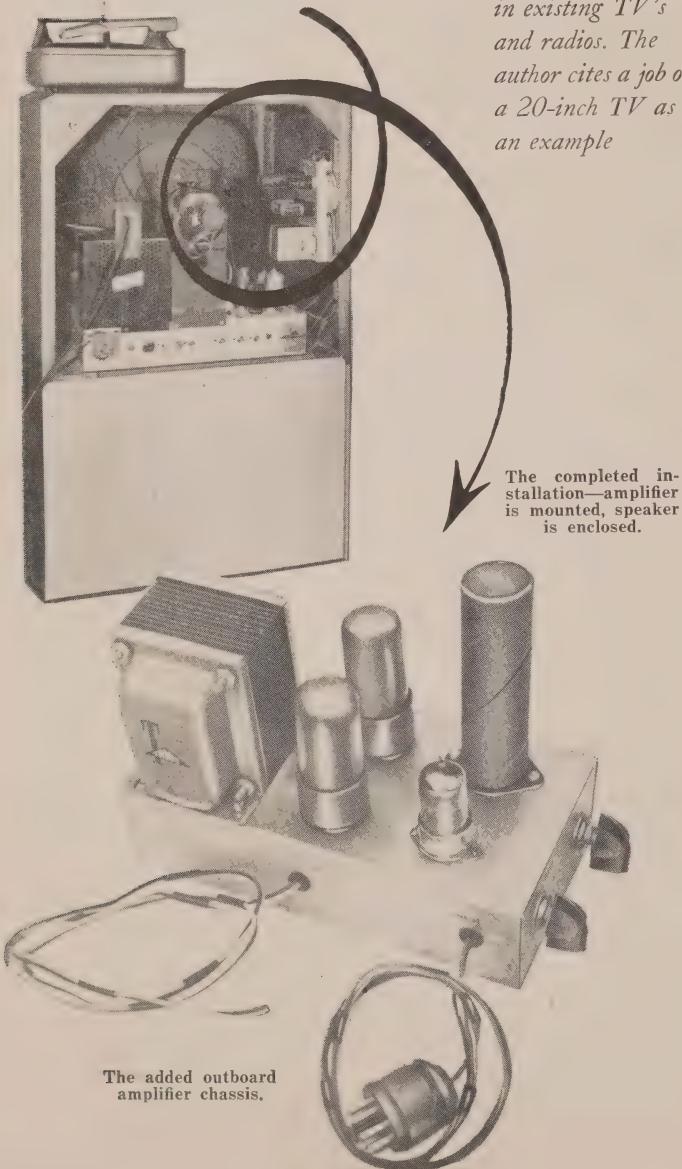
While intended for educational purposes, primarily language instruction, two machines marketed by Educational Laboratories may be used for home stereo recording and playback. Models M-6A and M-7 both employ staggered heads and are respectively priced at \$269 and \$295. At present the Educorder Duals, as they are called, do not offer response beyond 7,500 cycles at 7.5 ips, but a communication from Educational Laboratories states, "In the near future we will bring a companion model into production which will have improved frequency response, suitable for hi-fi recording and reproduction of stereophonic sound." The company offers two separate speakers in a split case (model EL-2S) for \$48. Separate power amplifiers are not necessary as the Educorder Duals contain their own. The M-6A furnishes 1 watt per channel and the M-7 nearly 5 watts.

A portable battery-operated machine is manufactured by Amplifier Corporation of America. The Stereo-Magnemite uses staggered heads and has a price of \$395 for the 7.5-ips model. Frequency response at this speed is 50-7,500 cycles. The transport has a spring-wound motor, which must be rewound every six minutes for the 7.5-ips model. The preamplifier is powered by batteries, which have a life of about 50 hours. The machine contains no erase head but for \$13.50 additional an erasing device in the form of a permanent magnet may be obtained. Accessory stereo headphones are available (these permit playback checks in the field). Another accessory of interest is a spare-tube kit consisting of selected low-microphonic tubes. TO BE CONTINUED

The second and concluding part of this article will discuss playback units, conversion kits and other components and will contain a listing of stereo equipment available to date.

By JOSEPH CHERNOF

AUDIO CONVERSIONS are PROFITABLE



Improve the sound in existing TV's and radios. The author cites a job on a 20-inch TV as an example

ONE of the service technician's more lucrative sidelines has been custom installation work. Most of these jobs are on high-fidelity audio equipment, although custom TV installations were quite popular a few years ago. The rewards in this field have been fairly high, yet few technicians have actively solicited this type of work.

Probably this is because technical ability in electronics does not necessarily qualify one as an interior decorator, cabinetmaker or carpenter. Conversely, the scarcity of technicians who can do satisfactory work in this line and the resulting high labor costs have priced custom installation beyond the reach of much of the potential market.

I have worked out what I believe a new approach to this dilemma. Here, the existing console radio-phonograph or TV set, already firmly established and accepted from a furniture standpoint, is audio-modified to give higher-fidelity performance. The modification is complete: the chassis is reworked, inferior components replaced and circuits poor in fidelity are redesigned. Even the acoustical properties of the cabinet are improved whenever possible.

Total costs are surprisingly small; most of the conversions I have worked on have been in the \$50 to \$75 range, yet results have been good. Best of all, the conversion of existing sets removes the appearance problem as a major factor. At the same time, you are able to present the customer with a complete, ready-made, easy-to-operate improved fidelity home sound system at a fraction of the cost of equivalent commercial sets or custom installations built from separately purchased units.

Only a few basic requirements need be met by a radio or TV set to justify its conversion: the set must be a console model, although a separate speaker enclosure plus a good speaker would do much to improve any table-model set. It should have a transformer type power supply; a push-pull audio output circuit is desirable. A reasonably substantial and attractive cabinet is just about a necessity. A built-in record changer would be convenient but not particularly important.

In the installation to be described, the original set—a Hoffman 20-inch console TV—met most of these qualifications. Its owner was an amateur musician of considerable ability. He had used the set, which was equipped with phono input jack, with an external three-speed record changer. Somewhere along the line he had heard some of his records played on a top-quality sound system and shortly thereafter asked

me to "make my equipment sound that way" in the most economical manner possible.

Approaching the problem

I examined the four main elements of his original sound system: phono cartridge, amplifier, speaker, and enclosure, to determine what, if any, changes or substitutions were needed. The phono cartridge was a turnover type crystal unit. Its frequency response was quoted as being flat from 80 to 5,000 cycles, which hardly placed it within the high-fidelity class. This was replaced by an Electro-Voice type EV-47 push-pull ceramic cartridge, ideal for this application since the ceramic unit provides improved fidelity while retaining the low cost and high output voltage of a crystal unit. The relatively high output voltage makes additional preamplification unnecessary.

Using the ceramic cartridge necessitated changing R1 (Fig. 1) from 1 to 2 megohms and R2 from 500,000 ohms to 1 megohm to provide the proper 3-megohm load termination. Capacitor C1 was changed from 47 to 22 μ f. The speaker, an inexpensive 12-inch unit, was checked and found deficient in fidelity and power-handling ability at both ends of its range. An Electro-Voice type SP-12B, a good-performing moderately priced coaxial speaker, was substituted.

The amplifier circuit was checked and response curves taken at several levels. Fig. 2, made with an input of 1 volt from a Hewlett Packard 200D audio oscillator, is the voltage across the voice coil. The relatively poor fidelity was attributed to the inadequate output transformer, the normal limitations of a single-ended output stage without feedback and the small values of coupling capacitors used in the audio circuits. The power supply seemed adequate, but I made a note to check for a possible need for additional hum filtering in the audio B-plus supply.

Rather than making the most of the set's single-ended output, I decided to change to push-pull. To reduce the amount of modification work required in the original TV receiver chassis, an external output chassis (Fig. 3) was built. This contained phase-inverter and push-pull output tubes, an output transformer and tone controls. The output transformer was a Triad type S-31A. Power for the external chassis and the audio input signal were obtained from an adapter which plugged into the socket originally occupied by the 6K6 audio output tube.

Conventional circuits were used. A 12AX7 twin-triode drove push-pull 6V6's. The first section of the 12AX7 provided additional amplification and the second section was used as a phase splitter of the split-load or cathodyne type. Both treble and bass tone controls are in the grid circuit of the first 12AX7 section. Since the external output chassis was to be mounted in the rear of the set (see photo) adjacent to

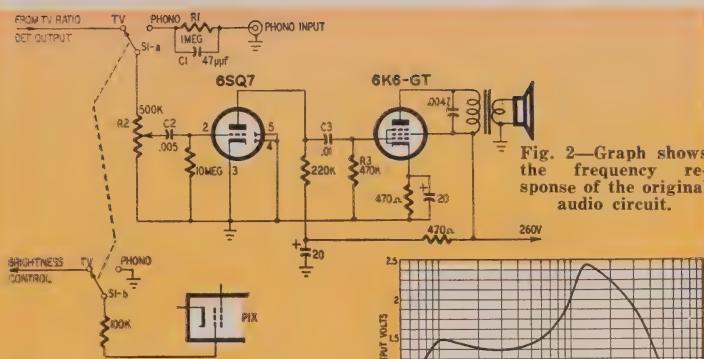


Fig. 1—Schematic of original audio circuitry in the Hoffman 183B chassis.

Fig. 2—Graph shows the frequency response of the original audio circuit.

the main chassis, these controls would not be readily accessible. However, since one of the main reasons for their use was to provide a flexible means for equalizing the various types of recording characteristics, it seemed unlikely that frequent readjustment would be necessary.

The power output stage is conventional; C1, C2, R1 and R2 are recommended by Triad engineers for use with the S-31A output transformer. The resistor and capacitor across each half of the output transformer primary wind-

ing work with the transformer leakage reactance, creating a low-pass filter to eliminate the extreme high frequencies and prevent instability. This permits substantial amounts of negative feedback with the three stages of the output chassis. The speaker connections are made directly to the 8-ohm tap of the secondary winding of the output transformer.

The remaining modifications were done on the main TV chassis. The major problem here was to obtain the necessary ac and dc power for the external

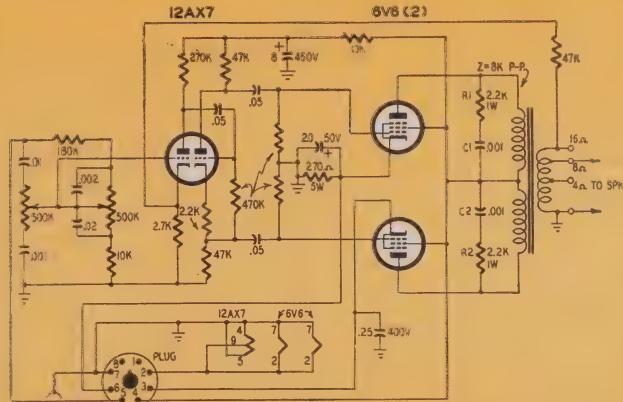


Fig. 3—Schematic diagram of the audio output amplifier fed from the TV set.

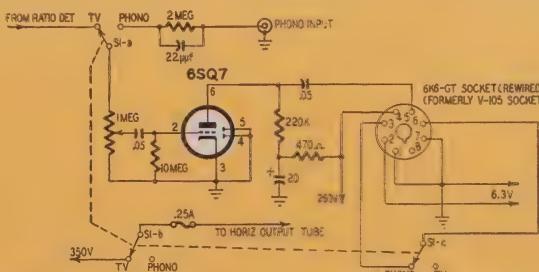


Fig. 4—Diagram shows modified circuits in the audio section of the televiser.

AUDIO—HIGH FIDELITY

chassis without overloading the TV power supply. The most straightforward approach seemed to be to disable some of the high-current-drain TV circuits when the set was used solely for audio reproduction. This method, however, would not provide a means of operating the external chassis during TV reception.

The problem was solved by rewiring the TV-phono switch (Fig. 4). Originally, this switch changed the audio amplifier input from the ratio detector output to the phono input jack. It also switched the picture-tube control grid from the brightness control circuit to ground, cutting off the picture tube when the phonograph was being used.

In the revised circuit, a triple-pole double-throw switch was substituted for S1-a and S1-b (ganged sections of the original TV-phono switch). In the new circuit S1-a performs as before in switching the audio amplifier input from the ratio detector output to phono input; S1-b is in series with the $\frac{1}{4}$ -amp fuse which carries the entire current of the horizontal output and damper tubes so that this supply is open in the PHONO position. The current thus obtained is ample for operation of the output chassis. Section S1-c opens the cathode return of one of the 6V6 output tubes which is run into the main chassis through the adapter. This cathode return is open for TV reception to cut down the B-plus drain of the output chassis to an amount only slightly more than that used by the original audio circuit.

Even using the single 6V6 output stage, due to the superior output transformer and speaker plus the negative feedback there is a substantial improvement in fidelity over the original TV audio circuit. Other changes made in the original TV receiver chassis are: R3 is deleted; C2 (.005 μ F) and C3 (.01 μ F) are both increased to .05 μ

No provisions were made to supply the additional filament current requirements for the external output chassis. Fortunately, the original power transformer was able to handle the increased load. This was not completely a matter of chance since a uhf adapter jack at the rear of the receiver indicated that there would be spare filament current available from the power transformer. It is possible that in other modifications of this type a filament transformer might have to be added. This is a fairly low-cost item and should present no problem.

Parts for conversion amplifier

(does not include changes made in TV chassis)
Resistors: 1—2,200; 1—2,700; 1—10,000; 3—47,000; 1—190,000; 1—270,000; 3—470,000 ohms, $\frac{1}{2}$ watt; 2—2,200; 1—10,000 ohms, 1 watt; 1—270 ohms, 5 watts; 2—500,000 ohm potentiometers.

Capacitors: 3—001; 1—002; 1—01; 1—02; 3—05; 1—0.25 $\mu\mu\mu$

Miscellaneous: 2—6V6's; 1—12AX7; 2—octal, 1—9-pin miniature socket; 1—octal adapter plug; 1—15-watt audio output transformer, good quality (Triad S-31A or equivalent) Pri: 8,000 ohms P-P; Sec: 4, 8, 16 ohms; 1—chassis; 1—3-pole 2-position switch; 2—knobs.

Reviewing the audio modifications made, an external high-quality audio output chassis was used in place of the original output tube. It was connected through an adapter to the original output socket to pick up power-supply voltages and the audio input. The external unit provides push-pull output for phonograph playback and highly improved single-ended output for TV reception. The existing TV-phono switch on the main receiver chassis was modified to provide the additional current needed during phono operation by disabling the horizontal output circuits.

(When the amplifier in Fig. 3 is used for TV reception, there is the possibility that the potential difference between the open cathode and the grounded heater will cause leakage or shorting between these two elements. This might be minimized by using a separate transformer for the 6V6 heaters and leaving the secondary ungrounded or applying around 150 volts B plus to the center tap. A separate power supply for the audio chassis would be the ideal solution.—Editor)

The final step was an attempt to improve the acoustical properties of the cabinet. The physical volume available in the speaker compartment was sufficiently limited to make impractical any attempt to change it into a resonant type structure. The next best approach was to convert the enclosure into something remotely approaching an infinite

baffle. This required complete suppression of any back radiation due to the speaker as well as eliminating completely any resonance effects due to the enclosure. It was necessary to line the whole interior of the speaker compartment with soundproofing material. This included covering the back and bottom of the enclosure, which were originally open (see photo). Not too much care was taken in applying and fastening the soundproofing material although nothing was left loose to vibrate at high sound-intensity levels. Additional pieces of lining were added to break up the interior of the enclosure and dampen any resonant tendencies.

This conversion job proved to be somewhat more complicated than average due to the changeover from single-ended to push-pull output. Reworking a set already featuring push-pull output would naturally be much simpler. Again, output transformer and speaker would be replaced with more adequate units.

Using a higher-quality output transformer would permit substantial amounts of inverse feedback with resulting improvement in fidelity.

There are, of course, many approaches to improving TV sound and using the TV audio amplifier for high-quality and even hi-fi reproduction. In some cases series-string filaments present new problems. This specific example shows what could be done. END

For Your Convenience . . .

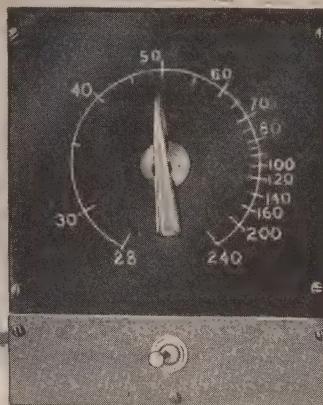
With the growing interest in construction—largely inspired by the transistor—RADIO-ELECTRONICS is including a larger number of construction articles. To make life easier for constructors (though hardly for the editors!), we are increasing the amount of information given in schematics and photographic illustrations.

● **SCHEMATICS** will generally have all parts coded (R1, C2, etc.) in addition to our long-time practice of having the value noted next to the part.

● **CODED PARTS LIST** will also be furnished. This should settle such parts list questions as: which of the five 100 K-ohm resistors specified are $\frac{1}{2}$ watt, 1 watt and 2 watt?

● **PHOTOGRAPHS** will have many more call-outs than in the past, to eliminate difficulties which might result from parts placement different from the original constructor's and to make parts location obvious without need for careful study.

Let us know what you think of these steps, and what others should be taken to help the reader make better use of his magazine.



stable

METRONOME at small cost

By TOM JASKI

MOST electronic metronomes described in recent years use either a multivibrator or some form of neon-tube oscillator. Both these oscillators are inherently unstable, particularly with variation in the supply voltage.

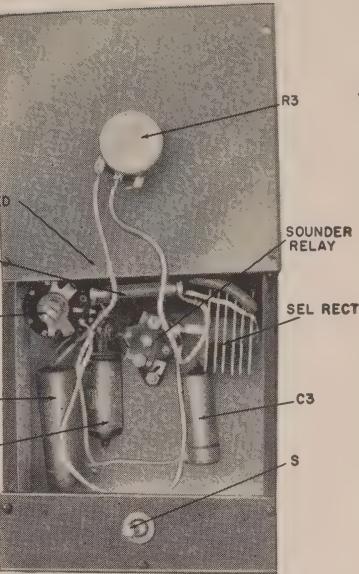
A cold-cathode tube is, with regard to trigger point, for all practical purposes unaffected by a reasonable variation in the supply voltage. In the metronome described here, which uses a 5823 cold-cathode relay tube, instability has been overcome to a great extent. Nevertheless, the circuit is simple and inexpensive.

The author's metronome, now in use for several years, has not yet required recalibration. It is instant starting, requiring no more warmup time than the space between beats, and produces a clear click very similar to that of the old mechanical metronomes. Visual indication could easily be added, but students should be looking at the music and not be distracted by the sight of a flashing light.

The circuit (see diagram), consists of a low-power dc supply with a 1-megohm voltage divider which charges the 0.5- μ f trigger capacitor. This capacitor charges through the 470,000-ohm fixed resistor and the 5-megohm variable resistor. When the trigger voltage of the relay tube is reached it conducts for somewhat less than a half-cycle and the capacitor discharges through the arc in the tube. The conducting tube draws a fairly strong current through the sounder relay.

This relay can be almost any type with a coil dc resistance of at least 500 ohms (to limit the current in the 5823). The contacts should be removed, except in the case where the armature is returned only through contact pressure. In that case at least one contact spring should be left on. I used a small G-E relay picked up in surplus. The relay should be rigidly fastened to the back of the box. The click is produced by the armature hitting the core of the relay.

A cold-cathode relay tube can be regarded for this purpose as an all-or-nothing device. Thus, if we provide a relatively rapidly rising voltage to trigger the tube, the variation in trigger point will be very small com-



Internal construction.

pared to the spacing between beats. By selecting the value of the time-determining capacitor and resistors so that the charging current of the capacitor is still rising sharply, this variation is again minimized. In the circuit shown, the voltage divider is set for approximately 120 volts. The tube triggers at about 67.5 volts, when the capacitor is only half-charged.

The 0.1- μ f capacitor synchronizes the triggering with the ac supply voltage, assuring that triggering always takes place at the same point on the half-cycle. In this way all beats are equally long and equally loud. The range of the metronome with the values shown is from 28 to 240 beats per minute, approximately equal to commercial metronomes.

Some calibrating can be done with the voltage-divider setting. But if a calibration means is to be provided, a better way is to replace the 470,000-ohm fixed resistor with a 1-megohm variable.

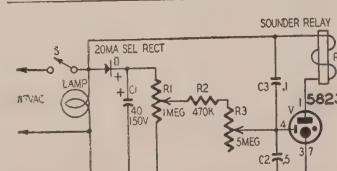
The front of the metronome is a piece of transparent ruby plastic, edge-lighted by a 115-volt 3-watt G-E indicator light. The plastic is backed up with a piece of fishpaper to make it opaque to the interior. The figures are scratched onto the plastic with a sharp scribe and a lettering guide—freehand only if you are extremely skillful at it.

A metal chassis box could be used for the enclosure, but a wooden or plastic box gave more satisfactory acoustic results.

END

Parts for metronome

R1—1-megohm pot	Lamp—115-volt 3-watt pilot light (G-E 3S6 or equivalent)
R2—470,000 ohms, $1/2$ watt	Ry—Relay (dc resistance at least 500 ohms—see text)
R3—500,000-ohm pot	S—spst switch
C1—40- μ uf, 150 volts	Cabinet (see text)
C2—0.5 μ f, 400 volts	Voltmeter for 5823
C3—0.1 μ f, 400 volts	
D—20-ma selenium rectifier	
V—5823	



HEATHKIT ETCHED CIRCUIT, PUSH-PULL

New



MODEL O-11

Shpg. Wt.
21 Lbs.

\$69.50

- * An improved model of what was already an outstanding instrument.
- * Performance is unmatched in this price range.
- * Incorporates the extra features required for color TV servicing.

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5
BIG
REASONS
WHY



**HEATH
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A SUBSIDIARY OF DAYSTROM, INC.

BENTON HARBOR 20, MICH.

5" Oscilloscope Kit COLOR TV

The previous Heathkit oscilloscope (Model O-10) which was already a most remarkable instrument, has been improved even further with the release of the Heathkit Model O-11. It incorporates all the outstanding features of the preceding-model, plus improved vertical linearity, better sync stability, especially at low frequencies, and much-improved over-all stability of operation, including less vertical bounce with changes in level. These improvements in the Model O-11 circuit make it even more ideally suited for color TV servicing, and for critical observations in the electronic laboratory. Vertical response extends from 2 CPS to 5 MC without extra switching. Response only down 1½ DB at 3.58 MC. The 11-tube circuit features a 5UP1 cathode-ray tube. Sync circuit functions effectively from 20 CPS to better than 500 kc in five steps. Modern etched circuit boards employed in the oscilloscope circuit cut assembly time almost in half, permit a level of circuit stability never before achieved in an oscilloscope of this type, and insure against errors in assembly. Both vertical and horizontal output amplifiers are push-pull. Built-in peak-to-peak calibrating source — step-attenuated input — plastic molded capacitors and top-quality parts throughout — pre-formed and cabled wiring harness — and numerous other "extra" features. A professional instrument for the serviceshop or laboratory. Compare its specifications with those of scopes selling in much higher price brackets. You can't beat it!

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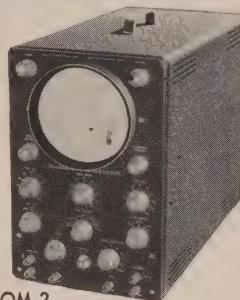
New HEATHKIT ETCHED CIRCUIT

5" Oscilloscope Kit

GREATEST SELECTION . . .

Whether your particular special interest is in servicing, ham-radio, high-fidelity, or just experimenting—there are Heathkits to fill your needs. You can equip an entire service shop or lab, buy a complete ham station or high-fidelity system, or set up a really deluxe home workshop, by choosing from the more than 70 different "do-it-yourself" electronic kits by Heath. Just glance through the kits displayed in this ad, and you will get some idea of the tremendous array of low-priced, high-quality electronic equipment available.

This new and improved oscilloscope retains all the outstanding features of the preceding model, but provides wider vertical frequency response, extended sweep-generator coverage, and increased stability. A new tube complement and improvements in the circuit make these new features possible. Vertical frequency response is essentially flat to over 1 mc, and down only $1\frac{1}{2}$ DB at 500 kc. The sweep generator multivibrator functions reliably from 30 to 200,000 CPS, almost twice the coverage provided by the previous model. Deflection amplifiers are push-pull, and modern etched circuits are employed in critical parts of the design. A 5BP1 cathode-ray tube is used. The scope features external or internal sweep and sync, one volt peak-to-peak reference voltage, 3-position step-attenuated input, adjustable spot-shape control, and many other "extras" not expected at this price level. A calibrated grid screen is also provided for the face of the CRT, allowing more precise observation of wave shapes displayed. The new Model OM-2 is designed for general application wherever a reliable instrument with good response characteristics may be required. Complete step-by-step instructions and large pictorial diagrams assure easy assembly.



MODEL OM-2

\$42⁵⁰

Shpg. Wt.
21 Lbs.

HEATHKIT LOW CAPACITY PROBE KIT

Oscilloscope investigation of high frequency, high impedance, or broad bandwidth circuits encountered in television requires the use of a low-capacity probe to prevent loss of gain, circuit loading, or waveform distortion. The Heathkit low-capacity probe may be used with your oscilloscope to eliminate these effects. It features a variable capacitor, to provide correct instrument impedance match. Also, the ratio of attenuation can be varied.

No. 342

\$3.50

Shpg. Wt. 1 Lb.



HEATHKIT ELECTRONIC SWITCH KIT

This handy device allows simultaneous oscilloscope observation of two signals by producing both signals, alternately, at its output. It features an all-electronic switching circuit, with no moving parts. Four switching rates are selected by a panel switch. Provides actual gain for input signals, and has a frequency response of ± 1 DB from 0 to 100 kc. Sync output provided to control and stabilize scope sweep. Will function at signal levels as low as 0.1 volt. This modern device finds many applications in the laboratory and service shop. It employs an entirely new circuit, and yet is priced lower than its predecessor.

MODEL S-3

\$21.95

Shpg. Wt. 8 Lbs.

HEATHKIT SCOPE DEMODULATOR PROBE KIT

Extend the usefulness of your oscilloscope by employing this probe. Makes it possible to observe modulation of RF or IF carriers found in TV and radio receivers. Functions much like an AM detector to pass only modulation of signal, and not the signal itself. Among other uses, it will be helpful in alignment work, as a signal tracer, and for determining relative gain. Applied voltage limits are 30 volts (RMS) and 500 volts DC. It uses an etched circuit board to simplify assembly.

NO. 337-C

\$3.50

Shpg. Wt. 1 Lb.

HEATHKIT VOLTAGE CALIBRATOR KIT

This entirely new voltage calibrator produces near-perfect square wave signals of known amplitude. Precision 1% attenuator resistors assure accurate output amplitude, and multivibrator circuit guarantees good, sharp square waves, as distinguished from clipped sine waves. Output frequency is approximately 1000 CPS. Fixed outputs selected by panel switch are: 0.3, 0.1, 0.3, 1.0, 3.0, 10, 30, and 100 volts peak-to-peak. Allows measurement of unknown signal amplitudes by comparing to known peak-to-peak output of VC-3 on an oscilloscope. Will also double as a square wave generator at 1000 cycles for determining gain, frequency response, or phase-shift characteristics of audio amplifiers. Equally valuable in the laboratory or in radio and TV service shops.

MODEL VC-3

\$12.50

Shpg. Wt. 4 Lbs.

HEATHKIT ETCHED CIRCUIT VACUUM TUBE



\$24.50

Shpg. Wt.
7 Lbs.

- * Easy to build — a pleasure to use.
- * 1% precision resistors employed for high accuracy.
- * Etched circuit board cuts assembly time in half.

HEATHKIT Etched Circuit RF PROBE KIT

This RF probe extends the frequency response of any 11-megohm VTVM so that it will measure RF up to 250 megacycles within $\pm 10\%$. Employs precision resistors for increased stability and ease of assembly. Ideal for extending service and laboratory applications of your Heathkit VTVM. Shpg. Wt. 1 lb.

No. 309-C

\$3.50

Shpg. Wt. 1 lb.

HEATHKIT SCOPE DEMODULATOR PROBE KIT

This probe functions like an AM detector to pass only modulation of signal and not signal carrier. Permits observation of modulation from RF or IF carriers in TV and radio receivers. Extends usefulness of your oscilloscope. Voltage limits are 30 V. rms, and 500 V. DC. Very valuable in service or laboratory applications. Shpg. Wt. 1 lb.

No. 337-C

\$3.50

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HEATHKIT 30,000 VOLT DC HIGH VOLTAGE PROBE KIT

This probe provides a multiplication factor of 100 on the DC ranges of the Heathkit 11-megohm VTVM. Precision multiplier resistor mounted inside the two-color plastic probe body. Plenty of insulation for completely safe operation, even at highest TV potentials. Designed especially for TV service work.

No. 336

\$4.50

Shpg. Wt. 2 Lbs.



HEATH COMPANY
A Subsidiary of Daystrom, Inc.
BENTON HARBOR 20, MICH.

Voltmeter Kit

The fact that this instrument is the world's largest-selling VTVM says a great deal about its accuracy, reliability, and overall quality. The V-7A is equally popular in the laboratory or service shop, and represents an unbelievable test equipment bargain, without a corresponding sacrifice in quality. Its appearance reflects the performance of which it is capable. A large 4½" panel meter is used for indication, with clear, sharp calibrations for all ranges. Front panel controls consist of a rotary function switch and a rotary range selector switch, zero-adjust, and ohms-adjust controls. Precision 1% resistors are used in the voltage divider circuits and etched circuits are employed for most of the circuitry. This makes the kit much easier to build, eliminates the possibility of wiring errors, and assures duplication of laboratory instrument performance. This multi-function VTVM will measure AC voltage (rms), AC voltage (peak-to-peak), DC voltage, and resistance. There are 7 AC (rms) and DC voltage ranges of 0-1.5, 5, 15, 50, 150, 500, and 1500. In addition, there are 7 peak-to-peak AC ranges of 0-4, 14, 40, 140, 400, 1400, and 4000. 7 ohmmeter ranges provide multiplying factors of X1, X10, X100, X1000, X10K, X100K, and X1 megohm. Center-scale resistance readings are 10, 100, 1000, 10K, 100K ohms, 1 megohm, and 10 megohms. A DB scale is also provided. The precision and quality of the components used in this VTVM cannot be duplicated at this price through any other source. Model V-7A is the kind of instrument you will be proud to own and use.

HEATHKIT 20,000 OHMS/VOLT VOM KIT

Sensitivity of this instrument is 20,000 ohms-per-volt DC and 5,000 ohms-per-volt AC. Measuring ranges are 0-1.5, 5, 50, 150, 500, 1500, and 5000 volts for both AC and DC. Also measures current in the ranges of 0-150 microamperes, 15 ma, 150 ma, 500 ma, and 15 a. Resistance ranges provide multipliers of X1, X100, and X10,000, resulting in center scale readings of 15, 15,000, and 150,000 ohms. DB ranges cover from -10 db to +65 db. Housed in attractive black bakelite case with plastic carrying handle, this fine instrument provides a total of 25 meter ranges MODEL MM-1 on its two-color scale. It employs a sensitive 50 microampere, 4½" meter and features all 1% precision multiplier resistors. Requires no external power, and is, therefore, valuable in portable applications where no AC power is available.

\$29.50

Shpg. Wt. 6 lbs.



HEATHKIT HANDITESTER KIT

The Model M-1 measures AC or DC voltage at 0-10, 30, 300, 1000, and 5000 volts. Direct current ranges are 0-10 ma, and 0-100 ma. Ohmmeter ranges are 0-3000 (30 ohm center scale) and 0-300,000 ohms (3,000 ohms center scale). Uses a 400 microampere meter for sensitivity of 1000 ohms-per-volt. A very popular test device for the home experimenter, electricians, and appliance repairmen, and for use as an "extra" instrument in the service shop. Its small size and rugged construction make it perfect for any portable application.

Easily slips into your tool box, glove compartment, coat pocket, or desk drawer. Top quality, precision components employed throughout.

MODEL M-1

\$14.50

Shpg. Wt. 3 lbs.

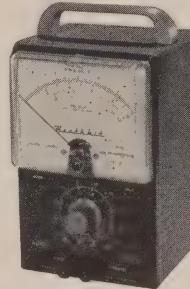
CONTROLLED QUALITY...

Incoming parts inspection, and inspection of material coming off of our own production line assures you of the finest "build-it-yourself" kit that money can buy. Each kit contains all the components you need for assembly—and you can have confidence in the quality of the parts themselves. In addition to this inspection procedure, an extensive proof-to-follow instructions and reliable performance.

HEATHKIT NEW AUDIO VACUUM TUBE

Voltmeter Kit

- * Brand new circuit for extended frequency response and added stability.
- * Ten accurate ranges from 0-01 to 0-300 volts.
- * Modern, functional panel styling. "On-off" switch at both extreme ends of range switch.



MODEL AV-3

\$29.95

Shpg. Wt.
5 Lbs.

This brand new AC vacuum tube voltmeter emphasizes stability, broad frequency response, and sensitivity. It is designed especially for audio measurements, and low-level AC measurements in power supply filters, etc. Employs a cascode amplifier circuit with cathode-follower isolation between the input and the amplifier, and between the output stage and the preceding stages. An extremely stable circuit with high input impedance (1 megohm at 1000 CPS). Response of the AV-3 is essentially flat from 10 CPS to 200 kc, and is usable for tests even beyond these frequency limits. Increased damping in the meter circuit stabilizes the meter for low frequency tests. Nylon insulating bushings at the input terminals reduce leakage, and permit the use of the 5-way Heath binding post.

The extremely wide voltage range covered by the AV-3 makes it especially valuable not only in high-fidelity and service work, but also in experimental laboratories. AC (RMS) voltage ranges are 0-01, .03, .1, .3, 1, 3, 10, 30, 100, and 300 V. Decibel ranges cover -52 DB to +52 DB. An entirely new circuit as compared to the previous model. Employs 1% precision multiplier resistors for maximum accuracy. Handles AC measurements from a low value of one millivolt to a maximum of 300 volts.

HEATHKIT AUDIO WATTMETER KIT

This instrument measures audio power directly at 4, 8, 16, or 600 ohms. Load resistors are built in. Covers 0-5 MW, 50 MW, 500 MW, 5 W, and 50 W full scale. Provides 5 switch-selected DB ranges covering from -10 DB to +30 DB. Large 4½" 200 microampere meter and precision multiplier resistors insure accuracy. Frequency response is ± 1 DB from 10 CPS to 250 kc. Functions from AC power line. Use in the audio laboratory or in home workshop.

MODEL AW-1

\$29.50

Shpg. Wt. 6 Lbs.



HEATHKIT AUDIO ANALYZER KIT

This multi-function instrument combines an AC VTVM, an audio wattmeter, and an intermodulation analyzer into one case, with combined input and output terminals and built-in high and low frequency oscillators. The VTVM ranges are .01, .03, .1, .3, 1, 3, 10, 30, 100, and 300 volts (RMS). Wattmeter ranges are .15 MW, 1.5 MW, 15 MW, 150 MW, 1.5 W, 15 W, 150 W. IM scales are 1%, 3%, 10%, 30%, and 100%. Provides internal load resistors of 4, 8, 16, or 600 ohms. A valuable instrument for the engineer or serious audiophile.

MODEL AA-1

\$49.95

Shpg. Wt. 13 Lbs.



HEATHKIT HARMONIC DISTORTION METER KIT

The HD-1 is equally valuable for the audio engineer or the serious audiophile. Used with a low-distortion audio signal generator, this instrument will measure the harmonic content of various amplifiers under a variety of conditions. Functions between 20 and 20,000 CPS, and reads distortion directly on the panel meter in ranges of 0-1, 3, 10, 30, and 100 percent full scale. Built-in VTVM for initial reference settings and final distortion readings has voltage ranges of 0-1, 3, 10, and 30 volts. 1% precision resistors employed for maximum accuracy. Features voltage regulation and other "extras." Meter calibrated in volts (RMS), percent distortion, and DB.

MODEL HD-1

\$49.50

Shpg. Wt. 13 Lbs.



HEATHKIT AUDIO OSCILLATOR KIT

Producing both sine waves and square waves, the Model AO-1 covers a frequency range of 20 to 20,000 CPS in three ranges. An extra feature is thermistor regulation of output for flat response through the entire frequency range. AF output is provided at low impedance, and with low distortion. Produces good sine waves, and good, clean square waves with a rise time of only two micro-seconds for checking square wave response of audio amplifiers, etc. Designed especially for the serviceman and high-fidelity enthusiast. A real dollar value in test equipment.

MODEL AO-1

\$24.50

Shpg. Wt. 10 Lbs.



HEATHKIT



\$34.50

Shpg. Wt.
8 Lbs.

- * Less than 0.1% distortion — ideal for hi fi work.
- * Large 4½" meter indicates output.
- * Step-type tuning for maximum convenience.

HEATHKIT RESISTANCE SUBSTITUTION BOX KIT

The RS-1 contains 36 10% 1-watt resistors ranging from 15 ohms to 10 megohms in standard RETMA values. All values are switch-selected for use in determining desirable resistance values in experimental circuits. Many applications in radio and TV service work.

\$5.50

Shpg. Wt. 2 lbs.

HEATHKIT CONDENSER SUBSTITUTION BOX KIT

This kit contains 18 RETMA standard condenser values that can be selected by a rotary switch. Values range from 0.00001 mfd to 0.22 mfd. All capacitors rated at 400 volts or higher. Capacitors are either silver-mica, or plastic-molded.

MODEL CS-1

\$5.50

Shpg. Wt. 2 lbs.

HEATHKIT DECADE CONDENSER KIT

Precision, 1% silver-mica capacitors are employed in the Model DC-1 in such a way that a selection of precision capacitor values is provided, ranging from 100 mmf (.0001 mfd) to 0.11 mfd (110,000 mmf) in 100 mmf steps. Extremely valuable in all types of design and development work. Switches are ceramic wafer types.

\$16.50

Shpg. Wt. 3 lbs.



MODEL DR-1

\$19.50

Shpg. Wt. 4 lbs.

HEATHKIT DECADE RESISTANCE KIT

The Model DR-1 incorporates twenty 1% precision resistors arranged around four-legged switches so that various combinations of switch positions will provide a total range of 1 ohm to 99,999 ohms. 1-, 10-, 100-, 1,000-, 10,000-, and 100,000 ohms. Switches are labeled "units," "tens," "hundreds," "thousands," and "ten thousands." Use it for ohm-meter calibration in bridge circuits as test values in multiplier circuits, etc.



HEATH COMPANY
A Subsidiary of Daystrom, Inc.
BENTON HARBOR 20, MICH.

Audio Generator Kit

This particular audio generator is "made to order" for high fidelity applications. It provides quick and accurate selection of low-distortion signals throughout the audio range. Three rotary selector switches on the front panel allow selection of two significant figures and a multiplier for determining audio frequency. In addition, it incorporates a step-type output attenuator and a continuously variable attenuator. Output is indicated on a large 4½" panel meter calibrated in volts and in db. Attenuator system operates in steps of 10 db, corresponding with the meter calibration. Output ranges are 0-.003, .01, .03, .1, .3, 1, 3, and 10 volts rms. A "load" switch provides for the use of a built-in 600 ohm load or an external load of higher impedance when required. Output and frequency indicators accurate to within ± 5%. Distortion is less than .1 of 1% between 20 cps and 20,000 cps. Total range is 10 cps to 100 kc. New engineering details combine to provide the user with an unusually high degree of operating efficiency. Oscillator frequency selected entirely by the switch method means that accurate resetability is provided. Comparable to units costing many dollars more, and ideal for use in critical high fidelity applications. Shop and compare, and you will appreciate the genuine value of this professional instrument.

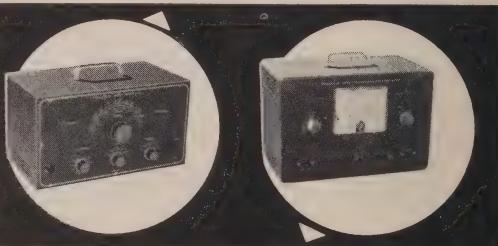
HEATHKIT AUDIO GENERATOR KIT

The Model AG-8 is a low cost, high performance unit for use in service shop, or home workshop. It covers the frequency range of 20 cps to 1 mc in five ranges. Output is 600 ohms, and overall distortion will be less than .4 of 1% from 100 cps through the audible range. Output is available up to 10 volts, under no load conditions, and output remains constant within ± 1 db from 20 cps to 400 kc. A five-step attenuator provides control of the output. Precision resistors are employed in the frequency determining network.

MODEL AG-8

\$29.50

Shpg. Wt. 11 lbs.



HEATHKIT VARIABLE VOLTAGE REGULATED POWER SUPPLY KIT

This power supply is regulated for stability, and the amount of DC output available from the power supply can be controlled manually from zero to 500 volts. Will provide regulated output at 450 volts up to 10 ma, or up to 130 ma at 200 volts output. In addition to furnishing B-plus, the power supply provides 6 volts AC at 4 amperes for filaments. Both the B-plus output and the filament output are isolated from ground. Ideal power supply for use in experimental work in the laboratory, the home workshop, or the ham shack. Large 4½" panel meter indicates output voltage or current.

MODEL PS-3

\$35.50

Shpg. Wt. 17 lbs.

HEATHKIT

BONUS PERFORMANCE . . .

If a single word had to be selected to describe Heath Company advertising policy, it would be "conservative." By this we mean that the performance specifications and features are not exaggerated, and that the descriptions are accurate. We specify performance on the conservative side so you can be sure of equaling or exceeding our specifications. In almost every instance our kits will do more than we claim. Extra care in construction, and calibration against an accurate standard can extend performance well beyond advertised levels.

Signal Generator Kit

* No calibration required with pre-aligned coils.

* Modulated or unmodulated RF output.

* 110 mc to 220 mc frequency coverage.



MODEL
SG-8

\$19.50 Shpg. Wt.
8 lbs.

Here is an RF signal generator for alignment applications in the service shop or the home workshop. Thousands of these units are in use in service shops all over the country. Produces RF signals from 160 kc to 110 mc on fundamentals on five bands. Also covers from 110 mc to 220 mc on calibrated harmonics. RF output is in excess of 100,000 microvolts at low impedance. Output is controllable with a step-type and a continuously variable attenuator. Front panel controls provide selection of either unmodulated RF output or RF modulated at 400 cps. In addition, two to three volts of audio at approximately 400 cps are available at the output terminals for testing AF circuits. Employs a 12AU7 and a 6C4 tube. Built-in power supply uses a selenium rectifier.

One of the most outstanding features about the Model SG-8 is the fact that it can be built in just a few hours, even by one not thoroughly experienced in electronics work. Complete step-by-step instructions combined with large pictorial diagrams assure successful assembly. Pre-aligned coils make calibration from an external source unnecessary.

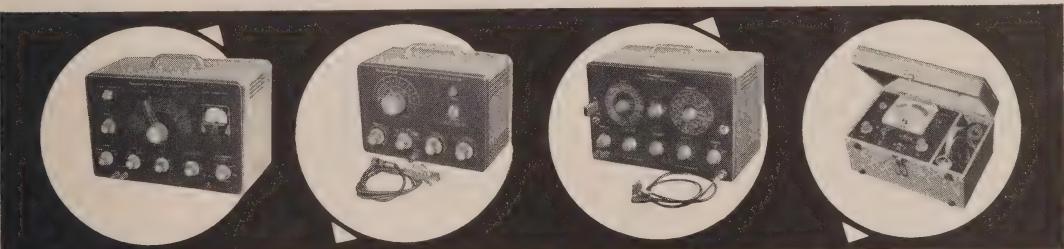
HEATHKIT LABORATORY GENERATOR KIT

This laboratory RF signal generator covers from 100 kc to 30 mc on fundamentals in five bands. The output signal may be pure RF, or may be modulated at 400 cycles from 0 to 50%. Provision for external modulation has been made. RF output available up to 100,000 microvolts. Output controlled by a fixed step and a variable attenuator. Output impedance is 50 ohms. Panel meter reads RF output or percentage of modulation. Incorporates voltage regulated B+ supply, double shielding of oscillator circuits, copper plated chassis, and other "extras."

MODEL LG-1

\$48.95

Shpg. Wt. 16 lbs.



HEATHKIT LINEARITY PATTERN GENERATOR KIT

This instrument supplies information for white dots, cross-hatch pattern, horizontal bar pattern, or vertical bar pattern. It feeds video and sync signals to the set under test, with completely controlled gain, and unusual stability. Covering channels 2 to 13, the LP-2 will produce 5 to 6 vertical bars and 4 to 5 horizontal bars. The dot pattern presentation is a must for the setting of color convergence controls in the color TV set. Panel provision made for external sync if desired. Use for adjustment of vertical and horizontal linearity, picture size, aspect ratio, and focus. Power supply is regulated for added stability. Essential in the up-to-date TV service shop.

MODEL LP-2

\$22.50

Shpg. Wt. 7 lbs.

HEATHKIT CATHODE RAY TUBE CHECKER KIT

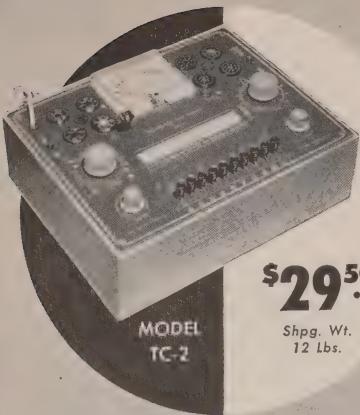
This instrument checks cathode emission, beam current, shorted elements, and leakage between elements in electro-magnetic picture tube types. It eliminates all doubt for the TV serviceman, and even more important, for the customer. Features its own self-contained power supply, transformer operated to furnish normal test voltages for the CRT. Employs spring-loaded switches for maximum operator protection. Large 4 1/2" meter indicates CRT condition on "good-bad" scale. Luggage-type portable case ideal for home service calls. Special "shadowgraph" test permits projection of light spot on screen. Also gives relative check of picture tube screen coating.

MODEL CC-1

\$22.50

Shpg. Wt. 10 lbs.

HEATHKIT



\$29.50

Shpg. Wt.
12 Lbs.

MODEL
TC-2

- * Attractive counter-style cabinet.
- * Wiring-harness simplifies assembly.
- * Large 4½" meter with two-color "good-bad" scale.
- * Separate tube element switches prevent obsolescence.

HEATHKIT PORTABLE TUBE CHECKER KIT

This portable tube checker is identical, electrically, with the Model TC-2. However, it is housed in an attractive and practical carrying case, finished in proxyl impregnated material. The cover is detachable, and the hardware is brass plated. This rugged unit is ideal for home service calls or any portable application.



\$34.50 Shpg. Wt.
1.5 Lbs.

MODEL
TC-2P

HEATHKIT DIRECT READING CAPACITY METER KIT

Operation of this instrument is simplicity itself. One has only to connect a capacitor to the terminals, select the proper range, and read the capacity value directly on the large 4½" meter calibrated in mmf and mfd. Ranges are 0 to 100 mmf, 1,000 mmf, 0.01 mfd, and 0.1 mfd full scale. Precision calibrating capacitors supplied. Not susceptible to hard capacity effects. Residual capacity less than 1 mmf. Especially valuable in production line checking, or in quality control.



MODEL CM-1

\$29.50

Shpg. Wt.
7 Lbs.

HEATH COMPANY
A Subsidiary of Daystrom, Inc.
BENTON HARBOR 20, MICH.



Tube Checker Kit

This fine piece of test gear checks tubes for quality, emission, shorted elements, open elements, and filament continuity. Will test all tube types normally encountered in radio and TV service work. Sockets provided for 4, 5, 6, and 7-pin, large, rectangular, and miniature types, octal and octal types, the Hytron 9-pin miniatures, and pilot lamps. Condition of tubes indicated on a large 4½" meter with multi-color "good-bad" scale. An illuminated roll chart is built right in, providing test data for various tube types. This tester provides switch selection of 14 different filament voltage values from 0.75 volts to 117 volts. Individual switches control each tube element. Close tolerance resistors employed in critical test circuits for maximum accuracy. A professional instrument both in appearance and performance.

The Model TC-2 is very simple to build, even for a beginner. It employs a color-coded cable harness for neat, professional under-chassis wiring. Comes with attractive counter style cabinet, and portable cabinet is available separately. At this price, even the part-time serviceman can afford his own tube checker for maximum efficiency in service work.



MODEL 355

\$4.50

Shpg. Wt.
1 Lb.

HEATHKIT TV PICTURE TUBE TEST ADAPTER

Designed especially for use with the Model TC-2 tube checker. Use it to test TV picture tubes for emission, shorts, etc. Consists of 12-pin TV tube socket, 4 ft. cable, octal connector, and necessary technical data. Not a kit.

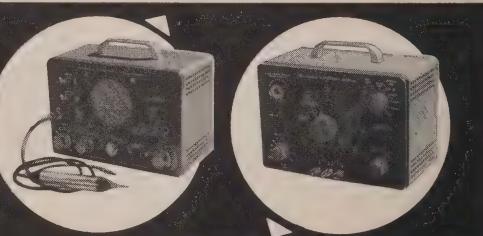
HEATHKIT VISUAL-AURAL SIGNAL TRACER KIT

Although designed primarily for radio receiver work, this valuable instrument finds extensive application in FM and TV servicing as well. Features a high-gain channel with demodulator probe, and a low-gain channel with audio probe. Will trace signals in all sections of a radio receiver and in many sections of a FM set or TV receiver. Uses built-in speaker and electron beam eye tube for indication. Also features built-in wattmeter and a noise locator circuit. Provision for patching speaker and/or output transformer into external set.

MODEL T-3

\$23.50

Shpg. Wt. 9 Lbs.



HEATHKIT CONDENSER CHECKER KIT

The Model C-3 consists of an AC powered bridge for both capacitive and resistive measurements. Bridge balance is indicated on electron beam eye tube, and capacity or resistance value is indicated on front panel calibrations. Measures capacity in four ranges from .00001 mfd to .005 mfd, .005 mfd to .5 mfd, .1 mfd to 50 mfd, and 20 mfd to 1000 mfd. Measures resistance in two ranges, from 100 ohms to 50,000 ohms, and from 10,000 ohms to 5 megohms. Selection of five different polarizing voltages for checking capacitors, from 25 volts DC to 450 volts DC. Checks paper, mica, ceramic, and electrolytic capacitors. Indicates power factor of electrolytic condensers.

MODEL C-3

\$19.50

Shpg. Wt. 7 Lbs.

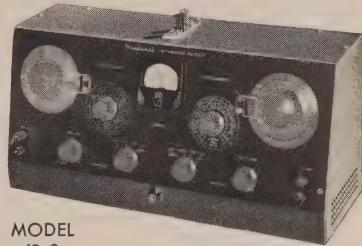
PIONEER DESIGN . . .

New and unique approaches to instrument and equipment designs are a Heath Company tradition. We concentrate all our development efforts on kit projects, since this is our prime activity—and not just a sideline. This logically results in more efficient, more reliable circuit designs—and you benefit from this constant engineering progress. Buying from the undisputed leader in the electronic kit field assures you of completely modern equipment, with outstanding advanced design features.

HEATHKIT

Impedance Bridge Kit

- * $\frac{1}{2}\%$ precision resistors and silver-mica capacitors.
- * Battery-type tubes, no warm-up required.
- * Built-in phase shift generator and amplifier.



MODEL
IB-2

\$59.50 Shpg. Wt.
12 Lbs.

The Model IB-2 is a completely self-contained unit. It has a built-in power supply, a built-in 1000 cycle generator, and a built-in vacuum tube detector. Provision has been made on the panel for connection to an external detector, an external signal generator, or an external power supply. A 100-0-100 microampere meter on the front panel provides for null indications. Measures resistance from 0.1 ohm to 10 megohms, capacitance from 10 mmf to 100 mfd, inductance from 10 mh to 100 h, dissipation factor (D) from 0.002 to 1, and storage factor (Q) from 0.1 to 1000. $\frac{1}{2}\%$ of 1% decade resistors employed for maximum accuracy. Typical accuracy figures are: resistance, $\pm 3\%$; capacitance $\pm 3\%$; inductance, $\pm 10\%$; dissipation factor, $\pm 20\%$; storage factor, $\pm 20\%$. Employs a Wheatstone bridge, a Capacity Comparison bridge, a Maxwell bridge, and a Hay bridge. Special two-section CRL dial provides maximum convenience in operation. Use the Model IB-2 for determining values of unmarked components, checking production or design samples, etc. A real professional instrument.

HEATHKIT "Q" METER KIT

The Q Meter permits measurement of inductance from 1 microhenry to 10 millihenries, "W" on a scale calibrated up to 250 full scale, with multiplying factors of 1 or 2, and capacitance from 40 mmf to 450 mmf, ± 3 mmf. Built-in variable oscillator permits testing components from 150 kc to 18 mc. Large 4½" panel-mounted meter is features. Very handy for checking peaking coils, chokes, etc. Use to determine values of unknown condensers, both variable and fixed. Compile data for coil winding purposes, or measure RF resistance. Distributed capacity, and Q of coils.

MODEL QM-1

\$44.50

Shpg. Wt. 14 Lbs.

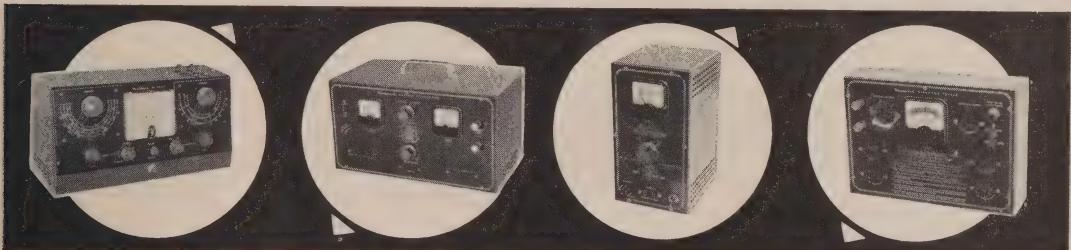
HEATHKIT ISOLATION TRANSFORMER KIT

This device isolates equipment under test from the power line. It is rated at 100 volt-amperes continuously, or 200 volt-amperes intermittently. AC-DC sets may be plugged directly into the IT-1 without the chassis becoming "hot." Additionally, since the IT-1 is fused, it is ideal for use as a buffer between the power line and a questionable receiver, or a new piece of equipment. Protects main fuses. Features voltage control, allowing control of the output from 90 volts to 130 volts. Panel meter monitors output voltage. A very handy device at an extremely low price.

MODEL IT-1

\$16.50

Shpg. Wt. 9 Lbs.



HEATHKIT 6-12 VOLT BATTERY ELIMINATOR KIT

This completely modern battery eliminator will supply DC output in two ranges for both 6-volt and 12-volt automobile radios. The output is variable for each range, so that operating voltage can be raised or lowered to determine how the receiver functions under adverse conditions. Range is 0-8 volts DC or 0-16 volts DC. Will supply up to 15 amperes on the 6-volt range, or up to 7 amperes on the 12-volt range. Two 10,000 microfarad output filter capacitors insure smooth DC output. Two separate panel meters indicate output voltage or output current. Makes it possible to test automobile radios inside at the workbench. Will also double as a battery charger.

MODEL BE-4

\$31.50

Shpg. Wt. 17 Lbs.

HEATHKIT 6-VOLT VIBRATOR TESTER KIT

This instrument functions very much like a tube checker, to test auto radio vibrators. Vibrator condition is indicated on a simple "good-bad" scale. Tests for proper starting and overall quality of operation, of both interrupter and self-rectifier types of 6-volt vibrators. The model VT-1 is designed to operate from any battery eliminator capable of delivering continuously variable output from 4 to 6 volts DC at 4 amperes or more. It is an ideal companion unit for the Heathkit Model BE-4 battery eliminator. The construction book for the VT-1 contains vibrator test chart for popular 6-volt vibrator types. A real time saver!

MODEL VT-1

\$14.50

Shpg. Wt. 6 Lbs.

HEATHKIT DX-100 PHONE AND CW



**MODEL
DX-100**
Shpg. Wt.
107 lbs.

\$189.50

Shipped motor freight unless otherwise specified.
\$50.00 deposit required on c.o.d. orders.

- * Phone or CW on 160, 80, 40, 20, 15, 11 and 10 meters.
- * Built-in VFO, modulator, and power supplies.
- * High quality components used throughout for reliable performance.
- * Features 5-point TVI suppression.

HEATHKIT COMMUNICATIONS TYPE ALL BAND RECEIVER KIT

This receiver covers 550 kc to 30 mc in four bands, and is ideal for the short-wave listener or beginning amateur. It provides good sensitivity and selectivity, combined with good image rejection. Amateur bands clearly marked on illuminated dial scale. Employs transformer type power supply—electrical bandspread—antenna trimmer—separate RF and AF gain controls—noise limiter—headphone jacks—and automatic gain control. Has built-in VFO for CW reception.

CABINET: Fabric covered cabinet with aluminum panel as shown. Part 91-15A. Shipping weight 5 lbs. \$4.95

MODEL AR-3

\$30.75

INCLUDING NEW
EXCISE TAX
(Less Cabinet)
Shpg. Wt. 12 lbs.



EASY ON THE BUDGET!

You can buy Heathkits on an easy time-payment plan that provides a full year to pay. Write for complete details and special order blank.



HEATH COMPANY

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BENTON HARBOR 20, MICH.

Transmitter Kit

The Heathkit DX-100 transmitter is in a class by itself in that it offers features far beyond those normally received at this price level. It takes very little listening on the bands to discover how many of these transmitters are in operation today. A truly amazing piece of amateur gear. The DX-100 features a built-in VFO and a built-in modulator. It is TVI suppressed, and uses pi network interstage coupling and output coupling. Will match antenna impedances from approximately 50 to 600 ohms. Extensive shielding is employed, and all incoming and outgoing circuits are filtered. The cabinet features interlocking seams for simplified assembly and minimum RF radiation outside of the cabinet. Provides a clean strong signal on either phone or CW, with RF output in excess of 100 watts on phone, and 120 watts on CW. Completely bandswitching from 160 through 10 meters. A pair of 1625 tubes are used in push-pull for the modulator, and the final consists of a pair of 6146 tubes in parallel. The VFO dial and meter face are illuminated, and all front panel controls are located for maximum convenience. Panel meter reads driver plate I, final grid I, final plate I, final plate voltage, and modulator current. The chassis is constructed of heavy #16 gauge copper-plated steel. Other high-quality components include potted transformers, ceramic switch and variable capacitor insulation, silver-plated or solid-silver switch terminals, etc. All coils are pre-wound, and the main wiring cable is pre-harnessed. The kit can be built by a beginner from the comprehensive step-by-step instructions supplied. It is a proven, trouble-free rig, that will insure many hours of "on-the-air" enjoyment in your ham shack.

HEATHKIT VFO KIT

You can go VFO for less than you might expect. Here is a variable frequency oscillator that covers 160, 80, 40, 20, 15, 11, and 10 meters with three basic oscillator frequencies, that sells for less than \$20. Provides better than 10 volt average RF output on fundamentals. Plenty of drive for most modern transmitters. Requires a power source of only 250 VDC at 15 to 20 ma. and 6.3 VAC at 0.45A. Incorporates a regulator tube for stability. Illuminated frequency dial reads frequency directly on the band being employed. Temperature-compensated capacitors offset coil heating.

MODEL VF-1

\$19.50

Shpg. Wt. 7 lbs.



HEATHKIT CW TRANSMITTER KIT

This is the original low-priced Heathkit CW transmitter. Its reliable performance has been proven time and time again on the CW bands. Designed for crystal control, the Model AT-1 covers 80, 40, 20, 15, 11, and 10 meters. May be excited from external VFO. Plate power input up to 30 watts. Power supply built in. Panel meter indicates grid current or plate current for final. Incorporates pre-wound coils, copper-plated chassis, built-in line filter, profuse shielding, and top-quality parts throughout. Crystal socket and key jack on front panel. Built-in key-click filter, and single-knob bandswitching. 52-ohm coaxial output. Uses 6AG7 oscillator-multiplier, 6L6 power amplifier-doubler, and SU4G rectifier.

MODEL AT-1

\$29.50

Shpg. Wt. 15 lbs.

DOLLAR-SAVING ECONOMY . . .

There would be no particular achievement in selling inexpensive merchandise at a low price—although it is being done every day. However, there is something to crow about when, through tremendous purchasing power and factory-to-you distribution, Heath Company can offer top-quality equipment, using name-brand components, at such low prices. This is real economy, as opposed to the so-called "bargains". Needless to say, there is a big difference.

The DX-35 features a 6146 final amplifier to provide 65 watts plate power input on CW, with controlled carrier modulation peaks up to 50 watts on phone. In addition, it is a most attractive transmitter. Modulator and power supplies are built-in, and the rig covers 80, 40, 20, 15, 11, and 10 meters with a single band-change switch. Pi network output coupling provided for matching various antenna impedances. A 12BY7 buffer stage provided ahead of the final amplifier for plenty of drive on all bands. 12BY7 oscillator and 12AU7 modulator. Provision for switch selection of three different crystals. Crystals reached through access door at rear. Front panel controls marked "off—CW—stand-by—phone", "final tuning", "antenna coupling", "drive level control", and "band change switch". Panel meter indicates final grid current or final plate current. A perfect low-power transmitter both for the novice, and for the more experienced operator. A remarkable power package for the price. Incidentally, the price includes tubes, and all other components necessary for assembly. As with all Heathkits, comprehensive instruction manual assures successful assembly.

HEATHKIT ANTENNA IMPEDANCE METER KIT

This instrument employs a 100 microampere panel meter and covers the impedance range of 0-600 ohms for RF tests. Functions up to 150 mc. Used in conjunction with signal source, such as the Heathkit Model GD-1B grid dip meter, the Model AM-1 will determine antenna resistance and resonance, match transmission lines for minimum standing wave ratio, determine receiver input impedance, etc. Will also double as a phone monitor. A very valuable device for many uses in the ham shack.

MODEL AM-1

\$14.50

Shpg. Wt. 2 Lbs.



MODEL DX-35

\$56.95

Shpg. Wt.
24 Lbs.

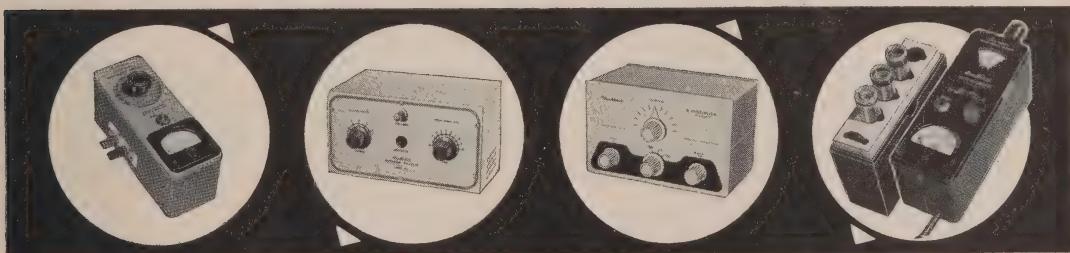
HEATHKIT "Q" MULTIPLIER KIT

The QF-1 functions with any receiver with an IF frequency between 450 and 460 kc that is not AC-DC type. Operates from the receiver power supply, requiring only 6.3 VAC at 300 ma. and 150 to 250 VDC at 2 ma. Simple to connect with cable and plugs supplied. Provides additional selectivity for separating two signals, or will reject one signal and eliminate heterodyne. A big help on crowded bands. Provides an effective Q of approximately 4,000 for sharp "peak" or "null". Tunes to any signal within the IF bandpass of the receiver, without changing main receiver tuning dial.

MODEL QF-1

\$9.95

Shpg. Wt. 3 Lbs.



HEATHKIT ANTENNA COUPLER KIT

This device is designed to match the Model AT-1 transmitter to a long-wire antenna. In addition to impedance matching, this unit incorporates an L-type filter which attenuates signals above 36 megacycles, thereby reducing TVI. Designed for 52 ohm coaxial input. Handles power up to 75 watts, 10 through 80 meters. Uses a tapped inductor and variable capacitor. Neon RF indicator on front panel. Copper-plated chassis—high quality components throughout—simple to build. Eliminates waste of valuable communications power due to improper matching. A "natural" for all AT-1 transmitter owners.

MODEL AC-1

\$14.50

Shpg. Wt. 4 Lbs.

HEATHKIT GRID DIP METER KIT

The grid dip meter was originally designed for the ham shack. However, its use has been extended into the service shop and laboratory. Continuous frequency coverage from 2 mc to 250 mc with pre-wound coils. 500 microampere panel meter employed for indication. Use for locating parasitics, neutralizing, determining RF circuit resonant frequencies, etc. Coils are included with kit, as is a coil rack. Front panel controls include sensitivity control for meter, and phone jack for listening to zero-beat. Will also double as an absorption-type wavemeter.

MODEL GD-1B

\$19.95

Shpg. Wt. 4 Lbs.

HEATHKIT BROADCAST BAND



MODEL BR-2

(Less Cabinet)
Shpg. Wt. 10 Lbs.

\$19.25

INCLUDING NEW
EXCISE TAX*

ATTENTION BEGINNERS . . .

This kit is an ideal "first project" if you have never built a Heathkit before. A good chance to "learn by doing."

- * Miniature tubes and high-gain IF transformer.
- * 5½-inch PM speaker.
- * Rod-type built-in antenna.
- * Provision for phono jack.
- * Good sensitivity and selectivity.
- * Transformer - operated power supply.

HEATHKIT PROFESSIONAL RADIATION COUNTER KIT

This sensitive and reliable instrument has already found extensive application in prospecting, and also in medical and industrial laboratories. It offers outstanding performance at a reasonable price. Front-panel meter indicates radiation level, and oral indication produced by panel-mounted speaker. Meter ranges are 0-100, 600, 6,000 and 60,000 counts per minute, and 0-.02, .1, 1 and 10 milliroentgens per hour. The probe, with expansion cord, employs type 6306 bismuth counter tube, sensitive to both beta and gamma radiation. It is simple to build, even for a beginner.

MODEL RC-1

\$79.95

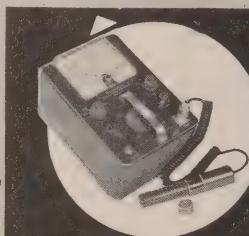
Shpg. Wt. 8 Lbs.



* Amazing new circuit for high efficiency.

* Compact, portable and rugged.

* Stable circuit requires only one 6 7/8 volt "B" battery and two 1 1/2 volt "A" batteries.



Receiver Kit

You need no previous experience in electronics to build this table-model radio. The Model BR-2 receiver covers 550 kc to 1620 kc and features good sensitivity and selectivity over the entire band. A 5½" PM speaker is employed, along with high gain miniature tubes and a new rod-type built-in antenna. Provision has been made in the design of this receiver for its use as a phonograph amplifier. The phono jack is located on the back chassis apron. A transformer operated power supply is featured for safety of operation, as opposed to the usual AC-DC supply commonly found in "economy radio kits." Don't let the low Heathkit price deceive you. This is the kind of set you will want to show off to your family and friends after you have finished building it.

Construction of this radio kit is very simple. Giant size pictorial diagrams and detailed step-by-step instructions assure your success. The construction manual also includes an explanation of basic receiver circuit theory so you can "learn by doing" as the receiver is built. The manual even provides information on resistor and capacitor color codes, soldering techniques, use of tools, etc. If you have ever had the urge to build your own radio receiver, the outstanding features of this popular Heathkit deserve your attention.

CABINET: Proxylin impregnated fabric covered plywood cabinet available for the BR-2 receiver as shown. Complete with aluminum panel, reinforced speaker grill, and protective rubber feet. Shipping weight 5 lbs., part No. 91-9A. **\$4.95***

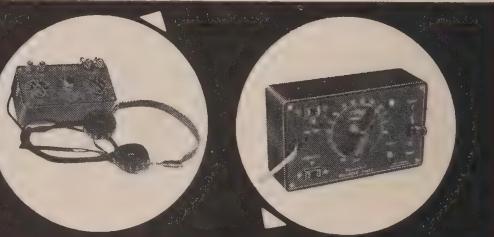
HEATHKIT CRYSTAL RECEIVER KIT

The crystal radio of Dad's day is back again, but with big improvements! The Model CR-1 employs a sealed germanium diode, eliminating the critical "cat's whisker" adjustment. It is housed in a compact plastic box, and features two Hi-Q tank circuits, employing ferrite core coils and variable air tuning capacitors. The CR-1 covers the standard broadcast band from 540 kc to 1600 kc, and no external power is required for operation. Could prove valuable for emergency signal reception. This easy-to-build kit is a real "learn by doing" experience for the beginner, and makes an interesting project for all ages.

MODEL CR-1

\$8.75

INCLUDING NEW
EXCISE TAX \$
Shpg. Wt. 3 Lbs.



HEATHKIT ENLARGER TIMER KIT

The Model ET-1 is an easy-to-build device for use by amateur or professional photographers in controlling the timing cycle of an enlarger. It covers the range of 0 to 1 minute with a continuously variable, clearly calibrated scale. The timing period is pre-set, and the timing cycle is initiated by depressing the spring-return switch to the "print" position. Front panel provision is made for plugging in the enlarger and a safelight. The safelight is automatically turned "on" when the enlarger is "off". Handles up to 350 watts. The timing cycle is controlled electronically for maximum accuracy and reliability. Very simple to build in only one evening, even by a beginner.

MODEL ET-1

\$11.50

Shpg. Wt. 3 Lbs.



HEATH COMPANY

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BENTON HARBOR 20, MICH.

COMPREHENSIVE INSTRUCTIONS . . .

The step-by-step assembly instructions provided with each Heathkit are the finest available anywhere. Each manual begins at the beginning, and assumes no previous training or experience on the part of the kit builder. This means that our kits can be built successfully by anyone who can follow instructions. As a matter of fact, new manuals are tested by having the kit built by someone in our office who has had no previous experience in electronics. This is your guarantee of complete and thorough instruction material.

HEATHKIT HIGH FIDELITY

Preamplifier Kit

- * 5 switch-selected inputs, each with its own level control.
- * Equalization for LP, RIAA, AES, and Early 78's.
- * Separate bass and treble tone controls, and special hum control.
- * Clean, modern lines and satin-gold enamel finish.

Literally thousands of these preamplifiers are in use today, because the kit meets or exceeds specifications for the most rigorous high-fidelity applications, and will do justice to the finest available program sources. Provides a total of 5 inputs, each with individual level controls (three high-level and two low-level). Frequency response is within 1 DB from 25 CPS to 30,000 CPS, or within 1½ DB from 15 CPS to 35,000 CPS. Hum and noise are extremely low, with special balance control for absolute minimum hum level. Tone control provides 18 DB boost and 12 DB cut at 50 CPS, and 15 DB boost and 20 DB cut at 15,000 CPS. Cabinet measures only 12-9/16" W. x 3¾" H. x 4¾" D, and it is finished in beautiful satin-gold enamel. 4-position turnover and 4-position roll-off controls provide "LP," "RIAA," "AES," and "early 78" equalization, and 8, 12, 16, and 1 flat position for roll-off. Derives operating power from the main amplifier, requiring only 6.3 VAC at 1 ampere and 300 VDC at 10 MA. Easy to construct from step-by-step instructions and pictorial diagrams provided.

HEATHKIT HIGH FIDELITY FM TUNER KIT

- * Illuminated slide-rule dial covers 88 to 108 MC.
- * Modern circuit emphasizes sensitivity and stability.
- * Housed in attractive satin-gold cabinet to match WA-P2 and BC-1.

This amazing new FM tuner can provide you with real high-fidelity performance at an unbelievably low price level. Covering 88 to 108 MC, the modern circuit features a stabilized, temperature-compensated, oscillator, A.G.C., broadbanded

IF circuits, and better than 10 UV sensitivity for 20 DB of quieting. A high gain, cascaded, RF amplifier is used ahead of the mixer to increase overall gain and reduce oscillator leakage. It employs a ratio detector for high efficiency without sacrificing high-fidelity performance. IF and ratio transformers are pre-aligned, as is the front end tuning unit. This means the kit can be constructed by a beginner, without elaborate test and alignment equipment. The FM-3A is designed to match the WA-P2 preamplifier and the BC-1 AM tuner. An illuminated slide-rule dial is employed for frequency indication. Step-by-step instructions and large pictorial diagrams assure success.

MODEL FM-3A

\$26.95

INCLUDING NEW
EXCISE TAX
(With Cabinet)
Shpg. Wt. 7 Lbs.



MODEL WA-P2 (With Cabinet)
Shpg. Wt. 7 Lbs.

\$19.75



HEATHKIT BROADBAND AM TUNER KIT

This AM tuner has been designed especially for high-fidelity applications. It incorporates a low-distortion detector, a broadband IF, and other features essential to usefulness in high-fidelity. Special voltage-doubler detector employs crystal diodes for low distortion. Sensitivity and selectivity are excellent. Audio response is ± 1 DB from 20 CPS to 2 kc, with 5 DB of pre-emphasis at 10 kc to compensate for station roll-off. Covers the standard broadcast band from 550 to 1600 kc. Incorporates a 10 kc whistle-filter and provides a 6 DB signal-to-noise ratio at 2.5 UV. RF and IF coils are pre-aligned, and power supply is built-in. Incorporates AVC, two outputs, and two antenna inputs.

MODEL BC-1

\$26.95

INCLUDING NEW
EXCISE TAX
(With Cabinet)
Shpg. Wt. 8 Lbs.

HEATHKIT ELECTRONIC CROSS-OVER KIT

This unusual device functions to separate low frequencies and high frequencies so that they may be fed to separate amplifiers and to separate speakers. This eliminates the need for conventional cross-over circuits, since the Model XO-1 does the complete job electronically. Cross-over frequencies of 100, 200, 400, 700, 1,200, 2,000 and 35,000 CPS are selectable with front panel controls on the XO-1, and a separate level control is provided for each channel. Minimizes inter-modulation distortion problems. Handles unlimited power, since frequency division is accomplished ahead of the power stage. Attenuation is 12 DB per octave, with sharp "knee" at cut-off frequency.

MODEL XO-1

\$18.95

Shpg. Wt. 6 Lbs.

HEATHKIT ADVANCED-DESIGN



**MODEL
W-5M**
Shpg. Wt. 31 Lbs.
Express Only

\$59.75

MODEL W-5
Consists of Model W-5M plus Model WA-P2 pre-amplifier.
Shpg. Wt. 38 Lbs.
Express only....\$79.50

- * Full 25 watt output with KT-66 output tubes.
- * All connectors brought out to front chassis apron.
- * Protective cover over all above-chassis components.

HEATHKIT DUAL-CHASSIS—WILLIAMSON TYPE HIGH FIDELITY AMPLIFIER KIT

This 20-watt high-fidelity amplifier employs the famous Acrosound Model TO-300 "ultra-linear" output transformer and uses 5881 output tubes. The power supply is built on a separate chassis, and the two chassis are inter-connected with a power cable. This provides additional flexibility in mounting. Frequency response is ± 1 DB from 6 CPS to 150 kc at 1 watt. Harmonic distortion is only 1% at 21 watts, and IM distortion is only 1.3% at 21 watts, 60 and 3,000 CPS. Output impedance is 4, 8, or 16 ohms. Hum and noise are 88 DB below 20 watts. A very popular high-fidelity unit employing top-quality components throughout.

MODEL W-3M: Shpg. Wt. 29 Lbs. Express only.....\$49.75
MODEL W-3: Consists of Model W-3M plus Model WA-P2 pre-amplifier. Shpg. Wt. 37 Lbs. Express only.....\$69.50

HEATHKIT 7-WATT AMPLIFIER KIT

This amplifier is more limited in power than other Heathkit models, but it still qualifies as a high-fidelity unit, and its performance definitely exceeds that of many so-called "high-fidelity" phonograph amplifiers. Using a tapped-screen output transformer of new design, the Model A-7D provides a frequency response of $\pm 1\frac{1}{2}$ DB from 20 to 20,000 CPS. Total distortion is held to a surprisingly low level. Output stage is push pull, and separate bass and treble tone controls are provided. Shpg. Wt. 10 Lbs.

MODEL A-7E: Similar to the A-7D, except that a 12SL7 tube has been added for pre-amplification. Two inputs, RIAA compensation, and extra gain. \$20.35*

MODEL A-7D
\$18.65
INCLUDING NEW EXCISE TAX*

MODEL A-9B
\$35.50
Shpg. Wt. 23 Lbs.

HIGH FIDELITY

Amplifier Kit

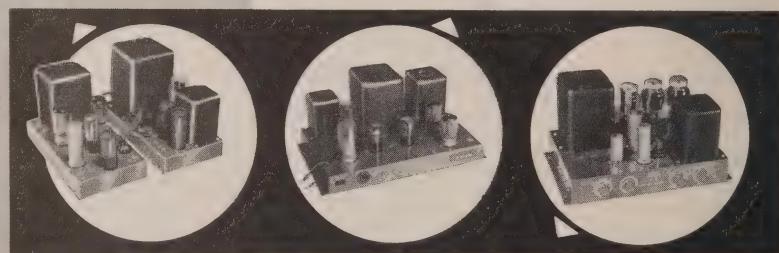
This 25 watt unit is our finest high-fidelity amplifier. Using a special design peerless output transformer, and KT-66 output tubes by Genalex, the Model W-5M provides performance characteristics unsurpassed at this price level. Frequency response is ± 1 DB from 5 to 160,000 CPS at 1 watt. Harmonic distortion is less than 1% at 25 watts and 1M distortion is less than 1% at 20 watts (60 and 3,000 CPS, 4 to 1). Hum and noise are 99 DB below 25 watts. Damping factor is 40 to 1. Input voltage for 5 watts output is 1 volt. Tubes employed are a pair of 12AU7's, a pair of KT-66's and a 5R4GY rectifier. Measures 13-3/32" W. x 8 1/2" D. x 8 1/4" H. Output impedance is 4, 8, or 16 ohms. Featured, also, is the "tweeter saver" which suppresses high frequency oscillation, and a new type balancing circuit requiring only a voltmeter for indication. This balance is easier to adjust, and results in a closer "dynamic" balance between output tubes. The Model W-5M provides improved phase shift characteristics, reduced IM and harmonic distortion, and improved frequency response. Conservatively rated high-quality components are used throughout to insure years of trouble-free operation. No technical background or training is required for assembly. Step-by-step instructions are provided for every stage of construction, and large pictorial diagrams illustrate exactly where each wire and component is to be placed. An amplifier for music lovers who can appreciate subtle differences in performance. Just ask the audiofile, who owns one!

HEATHKIT SINGLE CHASSIS—WILLIAMSON TYPE HIGH FIDELITY AMPLIFIER KIT

The 20-watt Model W-4AM Williamson type amplifier is a tremendous high-fidelity bargain. Combining the power supply and main amplifier on one chassis, and using a special-design output transformer by Chicago Standard brings you savings without a sacrifice in quality. Employing 5881 output tubes, the frequency response of the W-4AM is ± 1 DB from 10 CPS to 100 kc at 1 watt. Harmonic distortion is only 1.5% at 20 watts. Output impedance is 4, 8, or 16 ohms. Hum and noise are 95 DB below 20 watts.

MODEL W-4AM: Shpg. Wt. 28 Lbs. Express only.....\$39.75

MODEL W-4A: Consists of Model W-4AM plus Model WA-P2 pre-amplifier. Shpg. Wt. 35 Lbs. Express only.....\$59.50



HEATHKIT 20-WATT HIGH FIDELITY AMPLIFIER KIT

This high-fidelity amplifier features full 20-watt output using push pull 6L6 tubes. Built-in preamplifier provides 4 separate inputs, selected by a panel-mounted switch. It has separate bass and treble tone controls, each offering 15 DB boost and cut. Output transformer is tapped at 4, 8, 16, and 500 ohms. Designed primarily for home installations, but also used extensively for public address applications. True high-fidelity performance with frequency response of ± 1 DB from 20 CPS to 20,000 CPS. Total harmonic distortion only 1% (at 3 DB below rated output).



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HEATHKIT HIGH FIDELITY

Range Extending SPEAKER SYSTEM KIT

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Thank you,
HEATH COMPANY

This range extending unit is designed especially for use with the Model SS-1 speaker system. It consists of a 15" woofer, providing output between 35 and 600 CPS, and a compression-type super-tweeter that provides output between 4,000 and 16,000 CPS. Cross-over frequencies are 600, 1,600, and 4,000 CPS. The SS-1 provides the mid-range, and the SS-1B extends the coverage at both ends of the spectrum. Together, the two speaker systems provide output from 35 to 16,000 CPS within \pm 5 DB. This easy-to-assemble speaker enclosure kit is made of top-quality furniture-grade plywood. All parts are pre-cut and pre-drilled, ready for assembly and the finish of your choice. Complete step-by-step instructions are provided for quick assembly by one not necessarily experienced in woodworking. Coils and capacitors for proper cross-over network are included, as is a balance control for super-tweeter output level. The SS-1 and SS-1B can provide you with unbelievably rich audio reproduction, and yet these units are priced reasonably. The SS-1B measures 29" H. x 23" W. x 17½" D. The speakers are both special-design Jensens, and the power rating is 35 watts. Impedance is 16 ohms.

- * High quality speakers of special design — 15" woofer and compression-type super-tweeter.
- * Easy-to-assemble cabinet of furniture-grade plywood.
- * Attractively styled to fit into any living room. Matches Model SS-1.



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Shpg. Wt. 80 Lbs.

HEATHKIT HIGH FIDELITY SPEAKER SYSTEM KIT



MODEL
SS-1

\$39⁹⁵

Shpg. Wt. 30 Lbs.

- * Special design ducted-port, bass-reflex enclosure.
- * Two separate speakers for high and low frequencies.
- * Kit includes all parts and complete instructions for assembly.

This speaker system is a fine reproducer in its own right, covering 50 to 12,000 CPS within \pm 5 DB. However, the story does not end there. Should you desire to expand the system later, the SS-1 is designed to work with the SS-1B range extending unit — providing additional frequency coverage at both ends of the spectrum. It can fulfill your present needs, and still provide for the future. The SS-1 uses two Jensen speakers; an 8" midrange-woofer, and a compression-type tweeter. Cross-over frequency is 1,600 CPS, and the system is rated at 25 watts. Nominal impedance is 16 ohms. The cabinet is a ducted-port bass-reflex type. Attractively styled, the Model SS-1 features a broad "picture-frame" molding that will blend with any room decorating scheme. Pre-cut and pre-drilled wood parts are of furniture grade plywood. The kit is easy-to-build, and all component parts are included, along with complete step-by-step instructions for assembly. Can be built in just one evening, and will provide you with many years of listening enjoyment thereafter.

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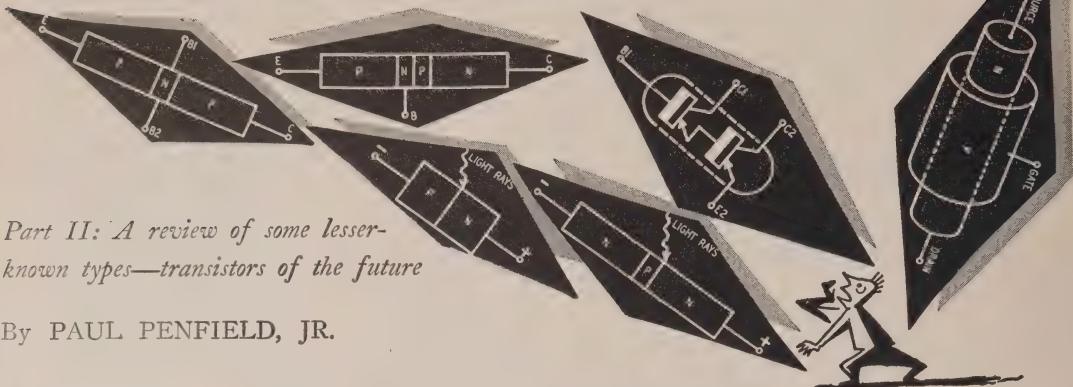
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Confused...about Transistor Types ???



Part II: A review of some lesser-known types—transistors of the future

By PAUL PENFIELD, JR.

AN unusual four-region transistor available now in small quantities is the *hook* transistor. This device (Fig. 1) is just like the junction transistor except for unusual construction of the collector.

Consider the right-hand three sections of the hook transistor by themselves. They form an n-p-n transistor. And the usual method of biasing the

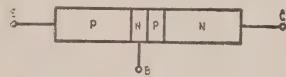


Fig. 1—Hook transistor—bias is same as for p-n-p junction transistors.

hook transistor (same as for the p-n-p junction models) is such that the n-p-n "transistor within a transistor" acts as though it had its emitter at the right, its base in the middle and its collector on the left where the hook transistor base is. Remember that a normal junction transistor, with the base left free, acts as a current multiplier for any electrons or holes at the collector junction.

With these facts in mind consider a hole which is injected from the hook transistor emitter into the base (the left-hand n-region). It suddenly sees itself in what looks like the collector of an n-p-n transistor (the right-hand three elements). And it does what every good hole does in like situations—it flows toward the base. However, at this point hook current multiplication takes place and many electrons are injected from the right. One of these fills the hole being considered, but most flow through to the hook transistor base. Thus the collector current is many times larger than the emitter current.

In this respect (having an alpha greater than 1) the hook transistor is very much like the point-contact type. And remember that one explanation for point-contact transistor current multiplication was in terms of just such a "hook multiplier" as described here.

The hook transistor, like the point-

contact device, is unstable in some circuits. And like the point-contact transistor it can be made into an oscillator by simply biasing it into a normally unstable region and hanging a tuned circuit across the proper terminals. However, because of the relatively large size of the base and the hook-multiplication regions, the hook transistor is not useful to quite as high frequencies.

Field-effect transistors

The operation of the field-effect transistor is so far removed from the operation of junction units that the same names are not even used for the three elements.

In a field-effect transistor (Fig. 2) voltage at the *gate* controls the flow of current from the *source* to the *drain*.

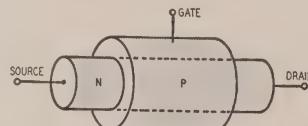


Fig. 2—Field-effect transistor—n-region extends from source to drain.

The material between the two low-resistance contacts at the source and the drain is n-type, and the gate material is p-type. The gate fits like a ring around the cylinder of n-type material.

The transistor is normally biased in such a way that the junction between the two regions is in reverse—that is, very little gate current flows.

The input gate voltage controls the current between the source and the drain. As this voltage is increased, more and more of the middle cylinder near the junction has its current carriers (excess electrons) removed by the gate voltage. This means, in effect, that less and less of the material between the source and the drain is available for current. At some gate voltage known as the "pinch-off voltage," the source-to-drain current, already low,

remains constant as the gate voltage is further increased.

The device amplifies because the gate voltage input is at a relatively high impedance—that of the reversely biased junction. The output is at a lower impedance and there can be considerable voltage gain to boot, so that the power gain can be high.

The high input impedance and relatively high output impedance of the field-effect transistor mean that amplifier stages can be cascaded directly without need for a coupling transformer and without much power loss. In addition, the impedance levels are not too far removed from those of an ordinary vacuum-tube triode and many practical circuits can be lifted complete from vacuum-tube practice and used with field-effect transistors without major changes.

Tetrode transistors

The normal junction tetrode is shown in Fig. 3. It operates exactly like a junction transistor except that the extra base contact can be used to limit the effective areas of the two junctions. This makes the tetrode useful at high

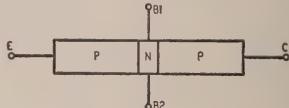


Fig. 3—Schematic of the junction tetrode, showing the two base terminals for applying a transverse voltage.

frequencies and for remote control of amplifier gain, such as in a.v.c. circuits.

Frequency range is raised in this transistor type by reducing the collector capacitance. This is done by putting a transverse voltage between the two base leads. The effect is to force all transistor action to occur at one side or the other of the transistor. In this way the effective junction area between the base and the collector is

ELECTRONICS

made very small. It is possible to control the effective junction area by varying the potential between the two base terminals. If the junction area is decreased, the collector capacitance is cut down and the frequency range thereby increased.

At lower frequencies, such as for audio applications, the tetrode transistor has useful properties, too. The gain of the transistor depends on the junction area available for transistor action. By varying the potential across the base transversely, this area can be varied. Practical automatic volume controls have been made by this sort of action.

Tetrode transistors are expected to become commonplace in the next few years as their applications multiply.

Phototransistors

Phototransistors and photodiodes are two different things. A photodiode (Fig. 4) looks exactly like any other diode—either point contact or junction (a junction model is illustrated)—except

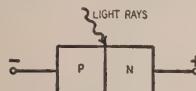


Fig. 4—Diagram of the photodiode.

that a window is provided in the case to let light reach the junction. The diode is normally biased in reverse so that little current flows. When light strikes the junction it creates electron-hole pairs. These flow apart and constitute current. Efficiencies very close to 100% have been observed for well-made photodiodes.

A phototransistor (Fig. 5) is merely a photodiode with a built-in hook amplifier. It is made just like an ordinary junction transistor (either p-n-p or n-p-n) and operated with the base lead disconnected. The reversely biased collector junction is illuminated and hook multiplication (which all junction trans-

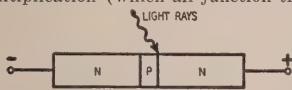


Fig. 5—The phototransistor—a photodiode with built-in hook multiplier.

sitors show with a base floating) results in far greater sensitivity than possible with merely a photodiode.

Some time ago the photodiode was called a phototransistor, and some writers still use the terms wrong—do not be confused.

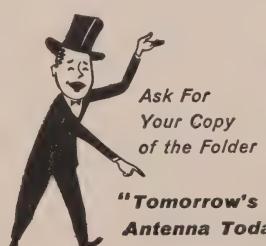
Tandem transistors

Just as two vacuum-tube sections are often put in the same envelope (such as the 6SN7), so it is possible to put two transistors in the same case. One interesting application of this idea is the tandem transistor. Two transistors are put in the same case and connected electrically inside. Fig. 6 tells the story. The first half is a smaller transistor than the second—both in size and rating. The first stage, which acts as a



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common-collector amplifier, supplies the entire base current—bias and signal—for the second stage. The second stage may be operated either as a common-collector or—more likely—a common-emitter stage.

Tandem transistors offer no advantage over using two normal junction transistors, except for the unique space-saving package.

The particular combination in Fig. 6 is not the only one and it may be profitable in the future for manufacturers to make several styles of tandem transistors (that is, internally connected) as well as dual transistors (two units not internally connected together). Twin units (matched trans-

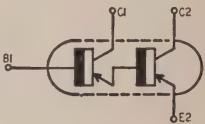


Fig. 6.—The basic tandem transistor.

sitors of the same or opposite polarity) will also undoubtedly become popular.

Miscellaneous types

Various other transistor types, too numerous to mention, have been either tried or dreamed up. Three of the most promising are the symmetrical transistor, the fieldistor and the point-junction transistor.

The symmetrical transistor is just like a junction transistor except that either end may be used as the collector and either as the emitter. This is quite unlike normal junction transistors in which connecting "backward" is not recommended. The symmetrical transistor is made by making the collector and emitter junctions exactly the same; this is not done for several reasons in normal junction transistors.

A fieldistor (do not confuse with the field-effect transistor) is made by placing a metal electrode close to a reverse-biased junction—close to but not touching. The field produced by this control element affects the amount of reverse current flowing. Since the input terminal does not actually touch the germanium elements, very high input impedances are possible—as high as possible with a tube grid. And moderately high output impedances are also possible although the power gain is low. Whether this device—not yet fully developed—will ever become popular remains to be seen.

Point-junction transistors are possible in which the emitter is a junction and the collector a point-contact. Some properties of such a device are interesting for computer applications, although these devices are also not yet fully developed.

The author hopes that some of the confusion so commonplace because of the many types of devices using the name "transistor" has been settled by this article, and that the reader has gained some valuable perspective. END

ELECTRONICS

ABBREVIATIONS and Symbols

By CHARLES S. KIMBALL

THE rapidly expanding fields of science bring with them a language very often all their own. Many of the words used are not words in the usual sense, but are fabricated from a group of words, ie, *radar* (radio direction and ranging). With these comes a vast array of engineering shorthand consisting of technical abbreviations, prefixes, symbols and letter designations, all designed to speed up the transmission of technical meaning.

This list is a compendium of those used in electronics and allied fields of science. It is based on current general usage within the electronics industry and is compiled from accepted reference sources such as *Reference Data For Radio Engineers*, *Radiotron Designers Handbook*, *Webster's New World Dictionary*, *Radar Systems Fundamentals*, etc.

This list differs considerably from the RADIO-ELECTRONICS abbreviations (January, 1956, page 138; March, 1956, page 108) in that it covers a broad field. RADIO-ELECTRONICS style is geared primarily for the general subject matter appearing in the magazine and in many cases abbreviations are used only in artwork.

This list is printed to give a broader coverage and for the benefit of the person who has looked up an abbreviation in the RADIO-ELECTRONICS list, only to find that obviously some other definition than the one given was intended. For instance, the letter B in our abbreviations stands for base (of a transistor) whereas this list has no less than eight definitions.

ABBREVIATION* DEFINITIONS

A—

- Ampere.
- Area.
- Battery or other supply source of vacuum-tube filament power.
- Class of vacuum-tube operation in which plate current flows continuously during the entire cycle.
- In rf transmitter emissions, designation for amplitude modulation.
- In radar, an indicator that presents target range data only.
- In vacuum-tube equations, the voltage gain of a stage.
- A type of broadcasting station which services primarily to communities other than the principal city of the area. A maximum effective rated power of 1 kw and an antenna height of 250 feet are permitted.
- U. S. Navy prefix for airborne equipment.

* Abbreviations are used to indicate either singular or plural; either as a noun or as an adjective.

Standardization is lacking in the use of capital letters and periods as used with abbreviations. Thus the term *Automatic Volume Control* is expressed as *AVC*, *A.V.C.*, *avc* or *a.v.c.*

In the use of Greek letters a lower case letter is used except where a capital is indicated.



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Offer wide-range response, breakdown and weatherproof driver units . . . bringing the best in Sound to public address

Devise "rim-centered" diaphragm/voice coil and magnet assemblies . . . eliminating need for shims and guides, ensuring shock and vibration-proof reliability

Depart from obsolete, erratic-performing

multi-cellular and slit type diffraction projectors . . . by introducing the still superior "reciprocating flare" principle for uniform wide-angle dispersion of high frequencies

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ABBREVIATION* DEFINITIONS

A+	—Point of positive filament voltage connection in a vacuum-tube circuit; the positive terminal of such a voltage source.
A—	—Point of negative filament voltage connection in a vacuum tube circuit; the negative terminal of such a voltage source.
Å	—Angstrom unit.
Å A	—In vacuum-tube equations, the voltage gain of a stage at midfrequency.
Å o	—Antiaircraft.
AA	—Automatic amplitude control (radar).
AAC	—Audio-to-air missile.
AAM	—Audio ave.
AAVC	—Class of vacuum-tube push-pull operation in which plate current flows for appreciably more than half but less than the entire input cycle.
AB	—Class AB1 same as AB. Grid current does not flow during any part of the cycle.
AB1	—Class AB2 same as AB. Grid current flows for at least a part of the cycle.
AB2	—Prefix used in the names of the electro-
Ab	—British term for nomograph.
Abac	—Automatic brightness control (TV).
abc	—Automatic bass control.
ac	—Automatic bass compensation.
A/C	—Alternating current.
ACC	—Aircraft.
ac-de	—Automatic chroma control.
adf	—Alternating or direct current.
ADJ	—Automatic direction finder (or finding).
af	—Adjustable.
afe	—Audio frequency.
AFT	—Automatic fire control (radar).
agc	—Automatic frequency control.
AGCA	—Audio-frequency transformer.
AGL	—Automatic gain control.
AGOS	—Automatic ground control approach (radar).
AJ	—Aircraft gun laying.
Alpha (A, α)	—Alpha-1 homing system.
AM	—Greek letter symbol for:
amp	—Absorption factor.
AMPL	—Attenuation constant.
A-N	—Angles and coefficients.
ANL	—Transistor current amplification factor (emitter to collector).
ANT	—Amplitude modulation.
apo	—Ampere.
APL	—Amplifier.
AR	—Anti-aim.
ASR	—Automatic noise limiter.
ASV	—Antenna.
AT	—Automatic phase control (color TV).
ATE	—Automatic picture control (TV).
ASM	—Air-to-surface missile.
ASR	—Airport surveillance radar.
ASV	—Air-to-surface vessel (radar).
AT	—Type of piezoelectric crystal extensively used between 500 kc and 10 mc; designated for the axis on which such a crystal is cut.
ATC	—Automatic temporal control (radar).
ATL	—Automatic tracking control (radar).
ATR	—Artificial transmission line (radar and other).
ATTEN	—Anti-TR tube (radar).
AU	—Attenuator.
AUM	—Angstrom unit; also Å.
AUTO	—Air-to-underwater missile.
AUTOTRANS	—Automatic.
Av	—Autotransformer.
ave	—Average.
ave	—Automatic volume control.
AWG	—Automatic volume expansion.
Az-El	—American wire gauge. Same as B&S wire gauge.
Azimuth elevation (radar indicator).	—Azimuth elevation (radar indicator).
B	—B—
B—	—Flux density.
Susceptance.	—Battery or other supply source of vacuum-tube plate voltage.
U. S. Navy prefix to designate identification equipment. Examples: ABK, BK, etc.	—U. S. Navy prefix to designate identification equipment. Examples: ABK, BK, etc.
—Class of vacuum-tube push-pull operation in which the tubes are biased almost to the point of cutoff. Plate current flows approximately half the input cycle.	—Class of vacuum-tube push-pull operation in which the tubes are biased almost to the point of cutoff. Plate current flows approximately half the input cycle.
In radar, the letter designation for the type of indicator that presents target azimuth and range data, a type not in general use.	—In radar, the letter designation for the type of indicator that presents target azimuth and range data, a type not in general use.
—A class of broadcasting station serving primarily a metropolitan district or principal city and its surrounding area, or primarily rural areas.	—A class of broadcasting station serving primarily a metropolitan district or principal city and its surrounding area, or primarily rural areas.
—Base of transistor.	—Base (of transistor).
—Point of positive plate voltage connection in a vacuum tube circuit; positive terminals of such a voltage source.	—Point of positive plate voltage connection in a vacuum tube circuit; positive terminals of such a voltage source.
—Point of negative plate voltage connection in a vacuum tube circuit; negative terminals of such a voltage source.	—Point of negative plate voltage connection in a vacuum tube circuit; negative terminals of such a voltage source.

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ABBREVIATION* DEFINITIONS

B ₁	terminal of such a voltage source.
	—Class B ₁ . Same as Class B. No grid current is permitted to flow during any part of the cycle. Also known as quiescent push-pull.
B ₂	—Class of vacuum-tube push-pull operation; the same as class B. Grid current flows during part of cycle.
BATT	—Battery.
BC	—Broadcast (frequency band).
BCI	—Broadcast interference.
Beta (β)	—Greek letter symbol for:
	—Phase constant.
	—Coefficients.
	—Angles.
bfo	—Transistor current amplification (base to collector).
B-H	—Beat frequency oscillator.
	—B-H Curve: A graph of the relationship between the magnetic flux (B) and the magnetic force (H); also known as a permeability curve.
BMNT	—Beginning, morning nautical twilight (navigation).
BO	—Barkhausen oscillation.
bo	—Beat oscillator.
BRL	—Bomb release line (radar navigation).
B&SWG	—Brown & Sharpe wire gauge; same as AWG.
BT	—Letter designation or a type of piezoelectric crystal extensively used between 4 and 10 megacycles; also the axis about which such a crystal is cut.
	—Blocking tube oscillator.
	—Bombing through overcast (radar).
	—British thermal unit.
BTU	—Birmingham wire gauge.
BWG	—Backward wave oscillator (radar).
C	—C—
	—Capacitance.
	—Cathode of a vacuum tube. The symbol generally used is K.
	—Class of vacuum-tube push-pull operation in which plate current flows for appreciably less than one-half of the input cycle.
	—In radar, the letter designation for the type of indicator that presents target azimuth and elevation data.
	—Battery or other supply source of bias voltage to a vacuum tube circuit.
	—Caliber of a gun.
C+	—Point of positive bias voltage connection of a vacuum-tube circuit; also the positive terminal of such a voltage.
C-	—Point of negative bias voltage connection of a vacuum tube circuit; the negative terminal of such a voltage.
CALIB	—Calibrate.
CATH	—Cathode.
CATH FOLL	—Cathode follower.
CCA	—Cameraman-controlled approach.
CCW	—Counter clockwise.
cemf	—Counter electromotive force.
centi	—1/100 of any given unit.
CGS	—Centimeter-gram-second system of units.
CH	—Choke.
CHAN	—Channel.
CHG	—Charge.
Chi (χ)	—Greek letter symbol for:
CIC	—Electric susceptibility.
	—Combat information center, U. S. Army designation for the department aboard ship in which all radar information is screened and disseminated; corresponds to U. S. Army filter center.
CKT	—Circuit.
CKT BRKR	—Circuit breaker.
cm	—Centimeter.
CMR	—Counter mortar radar.
co	—Crystal oscillator.
co	—Cutoff (vacuum tubes).
COAX	—Coaxial.
Coho	—Cohesive oscillator (radar).
COM	—Common.
COMCM	—Communications counter measures.
COND	—Control.
CONELRAD	—Control of electromagnetic radiation.
CONN	—Connection.
CONT	—Control.
CONV	—Convergence.
CONVTR	—Converter.
cp	—Candle power.
CPS	—Cycles per second.
C-R	—Cathode-ray tubes, etc.).
CRO	—Cathode-ray oscilloscope.
CRTI	—Cathode-ray tube indicator (radar).
CVG	—Composite video generator (radar).
CW	—Clockwise.
	—Continuous wave.
cycles	—Cycles per second.
	In vacuum-tube terminology:
C _g	—Grid capacitance.
C _{gh}	—Grid-heater capacitance.
C _{gp}	—Grid-plate capacitance.
C _k	—Grid-phate capacitance.
C _p	—Plate capacitance.
C _{ph}	—Plate-heater capacitance.
C _{pk}	—Plate-cathode capacitance.

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Take your choice of these Mallory wire-wound resistors, and you're sure of long service and stability on any replacement job.

Mallory vitreous enamel resistors are protected against moisture and corrosion by a special non-porous, non-alkaline vitrified coating . . . are wound on a high-stability steatite core. In both fixed and adjustable types, 5 to 200 watts.

Mallory axial lead resistors, famous for cool operating and easy mounting, are coated with a dense, non-corrosive cement that keeps moisture out, and assures good heat dissipation. Leads can't pull away from the winding. 4-watt and 7-watt ratings, in a full range of resistance values.

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Superior's New Model 770-A

The FIRST Pocket-Sized VOLT-OHM MILLIAMMETER

USING THE NEW "FULL-VIEW" METER

71% MORE SCALE AREA

Yes, although our new FULL-VIEW D'Arsonval type meter occupies exactly the same space used by the older standard 2½" Meters, it provides 71% more scale area. As a result, all calibrations are printed in large easy-to-read type and for the first time it is now possible to obtain measurements instead of approximations on a popular priced pocket-sized V.O.M.

- Compact — measures 3½" x 5¾" x 2¼". • Uses "Full View" 2% accurate, 850 Microampere D'Arsonval type meter.
- Housed in round-cornered, molded case. • Beautiful black etched panel. Depressed letters filled with permanent white, insures long-life even with constant use.

Specifications

6 A.C. VOLTAGE RANGES: 0-15/30/150/300/1500/3000 Volts. 6 D.C. VOLTAGE RANGES: 0-7.5/15/75/150/750/1500 Volts. 2 RESISTANCE RANGES: 0-10,000 Ohms, 0-1 Megohm. 3 D.C. CURRENT RANGES: 0-15/150 Ma., 0-1.5 Amps. 3 DECIBEL RANGES: -6 db to +18 db, +14 db to +38 db, +34 db to +58 db.

\$15⁸⁵
NET

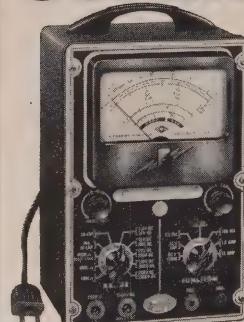
The Model 770-A comes complete with self-contained batteries, test leads and all operating instructions.



Superior's New Model 670-A

SUPER-METER

A COMBINATION VOLT-OHM MILLIAMMETER PLUS CAPACITY REACTANCE INDUCTANCE AND DECIBEL MEASUREMENTS.



D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts. A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts. OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 V. D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes. RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms. CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Good-Bad Scale for checking quality of electrolytic condensers). REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms. INDUCTANCE: .15 to 7 Henries 7 to 7,000 Henries. DECIBELS: -6 to +18, +14 to +38, +34 to +58.

ADDED FEATURE:

Built-in ISOLATION TRANSFORMER reduces possibility of burning out meter through misuse.

\$28⁴⁰
NET

The Model 670-A comes housed in a rugged crackle-finish steel cabinet complete with test leads and operating instructions.

Superior's New Model TV-60



FEATURES

- ✓ A sensitive, accurate Volt-Ohm-Milliammeter with giant meter and mirrored scale.
- ✓ An accurate direct-reading Capacity meter.
- ✓ A Kilovoltmeter.
- ✓ An R.F. Signal Tracer.
- ✓ An Audio Signal Tracer.
- ✓ Giant recessed 6½" inch 40 Microampere meter with mirrored scale assures accuracy and easy-reading. All calibrations are printed in large, easy-to-read type. Fractional divisions are easily read with the aid of the mirrored scale.

20,000 OHMS PER VOLT ALL METER

Includes services never before provided by an instrument of this type.

- ✓ The line cord, used only when making Capacity measurements, need be plugged in only when using that service. It is out of the way, stored in its plug-in compartment of all other times.
- ✓ A built-in Isolation Transformer automatically isolates the Model TV-60 from the power line when the capacity service is in use.
- ✓ Selected, 1% zero temperature coefficient metallized resistors are used as multipliers assuring unchanging accurate readings on all ranges.
- ✓ Use of the latest type of printed circuit guarantees maintenance of top quality standard in the production runs of this precise instrument.
- ✓ A new improved type of high-voltage probe is used for the measurement of high voltages up to 30,000 Volts. This service will be required when servicing color TV receivers.
- ✓ Simply plug-in the R.F. probe and convert the Model TV-60 into an efficient R.F. SIGNAL TRACER permitting the measurement of stage-gain and cause of trouble in the R.F. and I.F. circuits of A.M., F.M., and TV receivers.
- ✓ Plug in the Audio probe and convert the Model TV-60 into an efficient AUDIO SIGNAL TRACER. Measure the signal levels and comparative efficiency of hearing-aids, public-address systems, the amplifier sections of Radio & TV receivers, etc.

Read and compare features and specifications below!

SPECIFICATIONS

8 D.C. VOLTAGE RANGES: (At a sensitivity of 20,000 Ohms per Volt) 0 to 15/75/150/300/750/1500/7500/30,000 Volts.

7 A.C. VOLTAGE RANGES: (At a sensitivity of 5,000 Ohms per Volt) 0 to 15/75/150/300/750/1500/7500 Volts.

3 RESISTANCE RANGES: 0 to 2,000/200,000 Ohms, 0-20 Megohms.

2 CAPACITY RANGES: .00025 Mfd. to 30 Mfd.

5 D.C. CURRENT RANGES: 0-7.5 Microamperes, 0 to 7.5/75/750 Milliamperes, 0 to 15 Amperes.

3 DECIBEL RANGES: -6 db to +58 db.

R. F. SIGNAL TRACER SERVICE:

Enables following the R.F. signal from the antenna to speaker of any radio or TV receiver and using that signal as a basis of measurement to first isolate the faulty stage and finally the component or circuit condition causing the trouble.

AUDIO SIGNAL TRACER SERVICE:

Functions in the same manner as the R.F. Signal Tracing service specified above except that it is used for the location of cause of trouble in all audio and amplifier systems.

Model TV-60 comes complete with book of instructions; pair of standard leads; probe; high voltage probe; detachable line cord; R. F. Signal Tracer Probe; R. F. and Audio Signal Tracer Probe; Phono lead; for all above accessories is also included. Price complete. Nothing else to buy. Only

\$52⁵⁰
NET

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**Superior's New
Model TC-55**

TUBE TESTER FOR



The Experimenter or Part-time Serviceman, who has delayed purchasing a higher priced Tube Tester. The Professional Serviceman, who needs an extra Tube Tester for outside calls. The busy TV Service Organization, which needs extra Tube Testers for its field men.

Speedy, yet efficient operation is accomplished by:

1. Simplification of all switching and controls.
2. Elimination of old style sockets used for testing obsolete tubes (26, 27, 57, 59, etc.) and providing sockets and circuits for efficiently testing the new Naval and Sub-Minar types.

You can't insert a tube in wrong socket. It is impossible to insert the tube in the wrong socket when using the new Model TC-55. Separate sockets are used, one for each type of tube base. If the tube fits in the socket it can be tested.

"Free-point" element switching system

The Model TC-55 incorporates a newly designed element selector switch system which reduces the possibility of obsolescence to an absolute minimum. Any pin may be used as a filament pin and the voltage applied between that pin and any other pin, or even the "top-cap".

Checks for shorts and leakages between all elements

The Model TC-55 provides a super sensitive method of

The Model TC-55 comes complete with operating instructions and charts. Housed in rugged steel cabinet. Use it on the bench — use it for field calls. A streamlined carrying case, included at no extra charge, accommodates the tester and book of instructions.

\$26 95
NET

**Superior's New
Model TV-11**



TUBE TESTER

SPECIFICATIONS:

★ Tests all tubes including 4, 5, 6, 7, Octal, Lock-in, Peanut, Bantam, Hearing Aid, Thyratrons, Sub-miniatures, Novals, Sub-minars, Proximity tube types, etc.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the R.M.A. base numbering system, the user can instantly know which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TV-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible

EXTRA SERVICE — The Model TV-11 may be used as an extremely sensitive Condenser Leakage Checker. A relaxation

to damage a tube by inserting it in the wrong socket.

★ Free-moving built-in roll chart provides complete data for all tubes.

★ Newly designed Line Voltage Control compensates for variation of any Line Voltage between 105 Volts and 130 Volts.

★ NOISE TEST: Phone-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

The Model TV-11 operates on 115-130 Volts 60 Cycles A.C. Comes housed in a beautiful hand-painted case and complete with portable cover.

\$47 50
NET

**Superior's New
Model TV-12**



TRANS-CONDUCTANCE TUBE TESTER

TESTING TUBES

★ Employs improved TRANS-CONDUCTANCE circuit. An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured. This provides the most suitable method of simulating the manner in which tubes actually operate in Radio & TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.

★ NEW LINE VOLTAGE ADJUSTING SYSTEM. A tapped transformer makes it possible to compensate for line voltage variations to a tolerance of better than 2%.

★ SAFETY BUTTON — protects both the tube under test and the instrument meter against damage due to overload or other form of improper switching.

★ NEWLY DESIGNED FIVE POSITION LEVER SWITCH ASSEMBLY. Permits application of separate voltages as required for both plate and grid of tube under test, resulting in improved Trans-Conductance circuit.

TESTING TRANSISTORS

A transistor can be safely and adequately tested only under dynamic conditions. The Model TV-12 will test all transistors in that approved manner, and quality is read directly on a special "transistor only" meter scale.

The Model TV-12 will accommodate all transistors including NPN's, PNP's, Photo and Tetrodes, whether made of Germanium or Silicon, either point contact or junction contact types.

Model TV-12 housed in handsome rugged portable cabinet sells for only

\$72 50
NET

ALSO TESTS TRANSISTORS!

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and we'll ship you the balance. No interest or

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postage paid, within 10 days and we'll refund your money.

About Testing Picture-Tubes . . .

Of course you can buy an "adapter" which theoretically will convert your standard Tube Tester into a picture - tube tester. Sounds fine - but - it simply doesn't work out that way!

We do not make nor do we recommend use of C.R.T. adapters because a Cathode Ray Tube is a very complex device and to properly test it, you need an instrument designed exclusively to test C. R. Tubes and nothing else. As compared to a make-shift adapter, which sells for

Superior's New Model TV-40



A complete picture tube tester for little more than the price of a "make-shift" adapter!! The Model TV-40 is absolutely complete! Self-contained, including built-in power supply, it tests picture tubes in the only practical way to efficiently test such tubes; that is by the use of a separate instrument which is designed exclusively to test the ever increasing number of picture tubes!

EASY TO USE:

Simply insert line cord into any 110 volt A.C. outlet, then attach tester socket to tube base (ion trap need not be on tube). Throw switch up for quality test...read direct on Good-Bad scale. Throw switch down for all leakage tests.

Tests all magnetically deflected tubes . . . in the set . . . out of the set . . . in the carton!!

SPECIFICATIONS:

- Tests all magnetically deflected picture tubes from 7 inch to 30 inch types.
- Tests for quality by the well established emission method. All readings on "Good-Bad" scale.
- Tests for inter-element shorts and leakages up to 5 megohms.
- Test for open elements.

Model TV-40 C.R.T. Tube Tester comes absolutely complete—nothing else to buy. Housed in round cornered, molded bakelite case. Only

**\$15⁸⁵
NET**

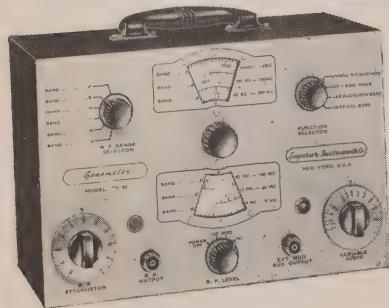
**Superior's New
Model TV-50**

GENOMETER

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:
A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

7 Signal Generators in One!

- ✓ R.F. Signal Generator for A.M.
- ✓ R.F. Signal Generator for F.M.
- ✓ Audio Frequency Generator
- ✓ Bar Generator
- ✓ Cross Hatch Generator
- ✓ Color Dot Pattern Generator
- ✓ Marker Generator



CROSS HATCH GENERATOR: The Model TV-50 Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of thin-splitting horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

DOT PATTERN GENERATOR (FOR COLOR TV): Although you will be able to use most of your regular standard equipment for servicing Color TV, an addition which you won't is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50 will enable you to adjust for proper color convergence.

R. F. SIGNAL GENERATOR: The Model TV-50 Genometer provides complete coverage for A.M. and television frequencies. Radio Frequencies from 10 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

MARKER GENERATOR: The Model TV-50 generates all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 1800 Kc., 2300 Kc., 2575 Kc., 2.5 Mc., 5 Mc., 10.7 Mc. (3579 Kc. is the color burst frequency.)

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50 Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

BAR GENERATOR: The Model TV-50 projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

THE MODEL TV-50
comes absolutely complete with shielded leads and operating instructions.

Only

**\$47⁵⁰
NET**

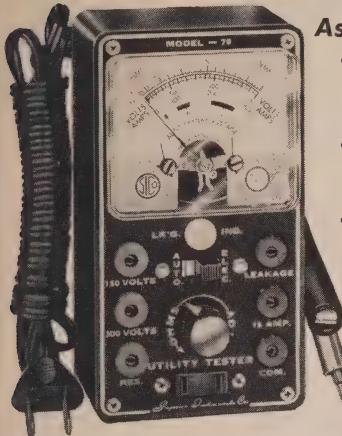
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FINANCE CHARGES ADDED. If not completely satisfied, return to us, no explanation necessary. (See approval form on page 87 for complete details.)

Superior's New Model 70 UTILITY TESTER®

FOR TESTING AND REPAIRING ALL ELECTRICAL APPLIANCES AUTOMOTIVE EQUIPMENT—TV TUBES



As an electrical trouble shooter the Model 70:

- Measures A.C. and D.C. Voltages, A.C. and D.C. Current, Resistances, Leakage, etc.
- Will measure current consumption while the appliance under test is in operation.
- Incorporates a sensitive direct-reading resistance range which will measure all resistances commonly used in electrical appliances, motors, etc.
- Leakage detecting circuit will indicate continuity from zero ohms to 5 megohms (5,000,000 ohms).
- Will test Toasters, Irons, Broilers, Heating Pads, Clocks, Fans, Vacuum Cleaners, Refrigerators, Lamps, Fluorescents, Fans, Switches, Thermometers, etc.
- Will test all TV tubes for open filaments, inter-element shorts, burned out tubes, etc. (Will not test TV tubes for quality. An emission type tester such as the models TC-55, TV-11, TV-12, etc., described on preceding pages is required to test tubes for quality.)

As an Automotive Tester the Model 70 will test:

- Both 6 Volt and 12 Volt Storage Batteries • Generators • Starters • Distributors • Ignition Coils
- Regulators • Relays • Circuit Breakers • Cigarette Lighters • Stop Lights • Condensers • Directional Signal Systems • All Lamps and Bulbs • Fuses • Heating Systems • Horns • Also will locate poor grounds, breaks in wiring, poor connections, etc.

Handsome round-cornered molded bakelite case, 3 1/8" x 5 7/8" x 2 1/4". Complete with all test leads. Also included is a 64 page book giving detailed instructions, for testing all electrical appliances, automotive equipment, TV tubes, etc.

\$15⁸⁵
NET

READ THIS!!

READ THIS!!

READ THIS!!

You don't pay for the Tester you select until AFTER you have examined it in the privacy of your home! All models

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Yes, when you send in the coupon (below) you are merely giving us permission to submit the item(s) you select for your approval. If, after trying it you decide to keep it, then and only then do you send us the down payment and pay the balance at the monthly indicated

rate with not one penny added for interest or finance charges! If not completely satisfied (we can't please everyone) you simply return the unit to us; no explanation necessary.

MOSS ELECTRONIC DISTRIBUTING CO., INC.
Dept. D-296, 3849 Tenth Ave., New York 34, N.Y.

Please send me the units checked. I agree to pay down payment within 10 days and to pay the monthly balance as shown. It is understood there will be no finance or interest charges added. It is further understood that should I fail to make payment when due, the full unpaid balance shall become immediately due and payable.

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Address.....

City.....Zone.....State.....

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\$7.40 within 10 days. Balance \$3.50 monthly for 6 months.
- Model TV-11 . . Total Price \$47.50
\$11.50 within 10 days. Balance \$6.00 monthly for 6 months.
- Model TV-40 . . Total Price \$15.85
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- Model TV-50 . . Total Price \$47.50
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\$22.50 within 10 days. Balance \$10.00 monthly for 5 months.
- Model TV-60 . . Total Price \$52.50
\$12.50 within 10 days. Balance \$8.00 monthly for 5 months.
- Model TV-70 . . Total Price \$15.85
\$3.85 within 10 days. Balance \$4.00 monthly for 3 months.

All Prices net, F.O.B., N.Y.C.

TACAN

New aerial navigation system combines the features of two older types to pin-point planes' position

By J. WHALEN

SINCE man started to fly he has searched for more precise methods of finding his way from one place to another. To get where he wants to go, a pilot needs to know his distance and direction (range and bearing) from a fixed point on Earth. Modern aviation relies mainly on electronics for this chore. Radio and radar signals, cutting through clouds, fog, rain, snow and darkness, permit aircraft to follow their routes over an unseen Earth.

Till recently, systems that gave bearings only have been satisfactory. The pilot could take his bearings on more than one station, find his position at the intersection of the bearing lines and measure his distance from that point to his destination. But planes are getting faster—and there are a lot more of them than a few years ago. Pilots—especially in jets—haven't the time to take bearings and compute distances.

The most modern aerial navigation system in general use, the visual omni-

range (VOR) tells the pilot his bearing relative to a fixed point on the ground. (VOR was described in RADIO-ELECTRONICS, February, 1951.) A more recent unit, DME (distance measuring equipment), which tells the pilot his distance from the VOR-DME station, is not so generally used. But a new and more precise navigational system, called Tacan (TACtical Air Navigation) worked out by the Navy in conjunction with Federal Telecommunications Laboratories, may supersede this entirely practical setup, simply because of greater accuracy and adaptability.

Unlike VOR-DME, Tacan gives both distance and bearing with one composite signal, with five times the bearing accuracy of the old system (and equal distance accuracy).

How Tacan operates

The system works in the 1000-mc portion of the spectrum. Transmitters and receivers are required for both ground and aircraft stations (see Fig. 1). Each ground station transmits on

a fixed frequency between 962 and 1024 or 1151 and 1213 mc. Channels are spaced 1 mc apart. The airborne equipment receives on any one of 126 selectable channels in the spectrum used by the ground stations and transmits on any one of the 126 selectable channels between the frequencies of 1025 and 1150 mc.

The 1000-mc signals are broken up into pulses, or rather pulse pairs, each pulse 3.2 microseconds wide and separated from its neighbor by 12 microseconds. Every second 3,600 of these pairs are transmitted.

How distance is measured

The airborne transmitter initiates the action by sending out interrogation pulses at a specific repetition rate. Spacing between pairs is made purposely random—no two airborne transmitters have the same spacing and the control circuits have a certain amount of built-in instability to permit the rate to jitter slightly. These pulses trigger the ground transmitter into replying to the airborne interrogator. The reply is received by the aircraft's equipment, which measures the time it took to reach the ground station and return, allows for the fixed delays in the equipment and shows the distance in nautical miles on an indicator.

Theoretically, the ground transmitter need not operate except in answer to interrogations. To transmit bearing information, however, and to keep the receiver up to top sensitivity, it has been found better to maintain a "constant-duty cycle" in which the same number of pulses are sent out whether interrogations are received or not. The gain of the receiver is such that when

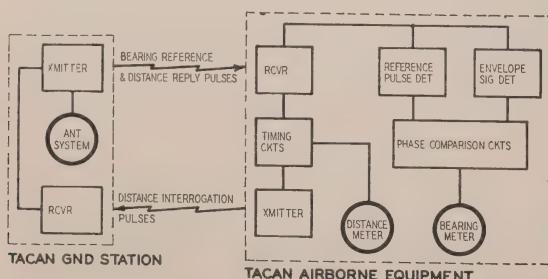


Fig. 1.—Diagram shows Tacan airborne and ground equipment and operation.



Idealized 3-D model of nine-lobe cardiod radiation pattern. Transmitter is aboard ship at focus of cardioid.

no interrogations are received random noise triggers the transmitter. As interrogations are received, an automatic gain control reduces sensitivity slightly so that the transmitter is triggered partly by receiver noise and partly by aircraft interrogations. If 100 interrogations are received, all the 2,700 pulse pairs used for distance measurement are triggered by plane-to-ground signals. (The remaining 900 pulse pairs are used for bearing information.)

Pulse pairs sent out in answer to interrogations have the same spacing as those sent by the interrogating aircraft. Noise-triggered pairs have random spacing. This is why the aircraft can recognize the reply to its own query. Only the reply meant for it will follow the spacing of the interrogating transmitter. Obviously, only the replies meant for the aircraft would give the right distance and bearing information.

How bearing is measured

Picture a lighthouse whose narrow beam rotates at some fixed rate. Assume that every time the beam passed north it triggered off a red light that could be seen equally well in all directions. Let's say you are out at sea in a boat somewhere within visual range of the light.

To gauge your bearing relative to north you would need only a stopwatch. You would simply measure the time between the instant the red light flashed (north) and the instant the rotating beam swept past your position. Knowing the rpm of the beam you could easily calculate your bearing.

For instance, say the light rotated

clockwise at 1 rpm and you measure 15 seconds between the red flash and the instant the beam swept past your position. Your bearing relative to the lighthouse would be 90° (east).

This is actually what any omnirange (including Tacan) does by electronic techniques. In Tacan, bearing information is contained in audio signals with which the pulse-modulated rf carrier is amplitude-modulated. The AM is imposed by a rotating antenna system; the strength of the signal at the output of the transmitter remains constant at all times.

Heart of the Tacan system is the ground antenna, Fig. 2. Our cover shows a photograph of the antenna, covered with its protective dome. The central element is a 3-inch diameter stationary array of seven biconical di-

poles stacked vertically. The central element is the only excited one.

Surrounding this element are two Fiberglas cylinders, one 5 inches and the other 33 inches in diameter. Both are rotated at 15 rps (900 rpm) around the central element. The inner cylinder carries a single parasitic element—the outer nine elements.

With just the one parasite (inner rotating cylinder) the circular pattern of the vertical array is transformed into the cardioid pattern of Fig. 3-a. This cardioid pattern rotates at 15 revolutions per second. To a receiver at a fixed point (or a plane whose position changes little in 1/15 second) the strength of the signal rises to a maximum, drops to a minimum and returns to the starting point 15 times a second—in other words the signal

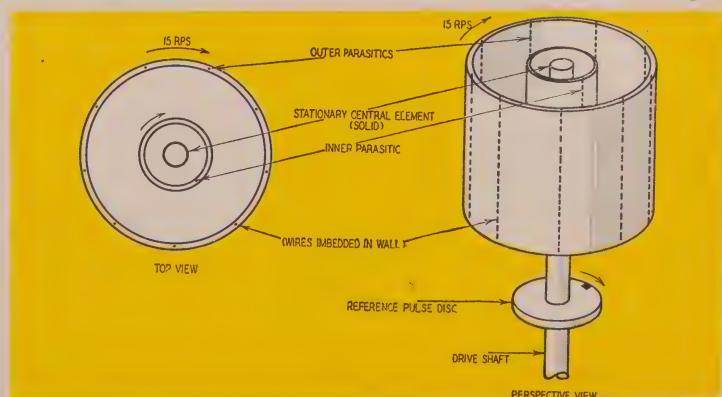


Fig. 2—Plan and perspective views of the antenna—"heart of the Tacan system."



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Radio & TV Receiver TROUBLESHOOTING AND REPAIR
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This big, 822-page book brings you the kind of PROFESSIONAL training that helps you handle the toughest radio and television service jobs as slick and as accurately as you now do the easy ones!

For service beginners, Radio & Television Receiver TROUBLESHOOTING AND REPAIR is a complete, easily understood professional training course. For experienced servicemen, it is the ideal way to "brush up" on specific jobs; to develop better troubleshooting methods and shortcuts; and to find quick answer to puzzling service problems.

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is amplitude-modulated at a 15-cycle rate. Since the amplitude goes through a 360° cycle for every revolution, the phase of the modulation (number of degrees from maximum amplitude or other recognizable point in the signal) is equivalent to the number of compass degrees from the same point.

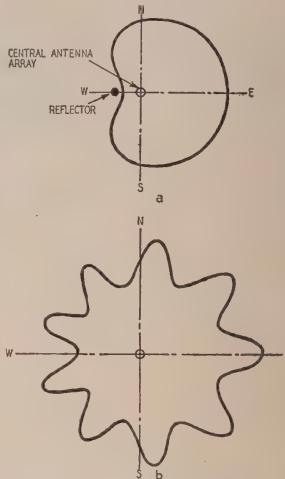


Fig. 3—The 15-cycle modulated pattern (a) and the 135-cycle one (b).

But so far we have no such point—nothing to take the place of the flash of our optical phase every time the beam pointed north. Actually, at the instant the maximum radiation of the ground-to-air Tacan signal is due east, a closely spaced group of pulses, easily recognized by the airborne receiver, is sent out as a reference signal. The airborne equipment measures the phase difference between this reference signal and the 15-cycle coarse variable signal to obtain the coarse bearing.

The fine modulating signal is produced by the outer cylinder with its nine parasitic elements. These superimpose a 135-cycle amplitude modulation on the 15-cycle pattern already being transmitted, since the cylinder, sweeping around at the same 15-cycle rate as the inner one, adds its nine lobes or ripples (Fig. 3-b) to the cardioid pattern as received at any distant station. The coarse system identifies the bearing sector within 20°; the fine system pinpoints it to within 1° within this sector.

Receiving circuits

To the airborne receiver, the cardioid pattern produces a 15-cycle sine

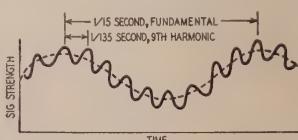


Fig. 4—How the 15-plus-135-cycle signal appears to the airborne receiver.

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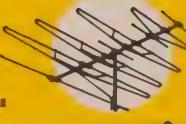
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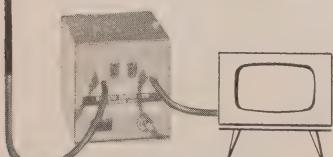
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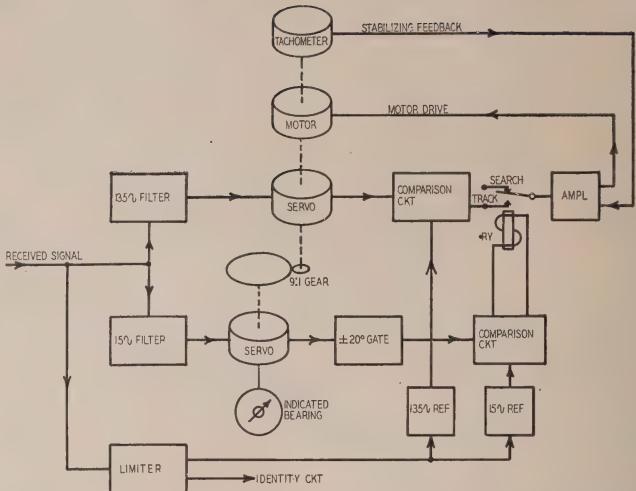


Fig. 5—Diagram of bearing circuits. (Peak rider and decoder circuits omitted.)

wave as shown in the dashed line of Fig. 4. The bearing circuits thus only have to measure the phase of the wave received at the instant the reference signal is received. The bearing circuits of an aircraft receiver are shown in simplified form in Fig. 5. After passing through a decoder in the earlier stages of the receiver, to eliminate all but properly spaced pairs, the signal is split, one portion going to reference burst decoders and the other through separate 15- and 135-cycle channels of a coarse-fine computing electromechanical servo.

As previously stated, the reference signal is transmitted when the maximum lobe is due east. But the reference signal is not at the maximum (which to the receiver is the rather broad peak of a sine wave) but 90° ahead of it. (A sine wave crosses the zero axis 90° beyond its peak and at that point is changing most rapidly in instantaneous value.)

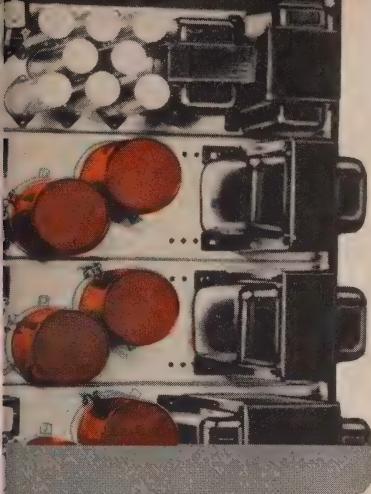
The sine wave received from the 15-cycle filter is applied to the servo and is made to produce a "gate" at the reference frequency. If the aircraft is due south of the beacon, this reference frequency will fall inside the gate. The indicator will indicate 0°, or north, and a relay is closed to switch the equipment from search to track. If the plane is not due south, the gate must be shifted in phase till the gate and reference signal coincide. This is done by a phase shifter which rotates at 4 rpm. As soon as the gate has been moved the requisite number of degrees, gate and reference signal will coincide, the meter indicates the difference from north, the relay closes and the 135-cycle circuits take over. These have their own reference pulse bursts and the process is repeated, with the rotation of the phase shifter being transmitted to the indicator through a 9-to-1 reduction gear. It is this that makes the bearing indications of the system so

much more accurate than older methods.

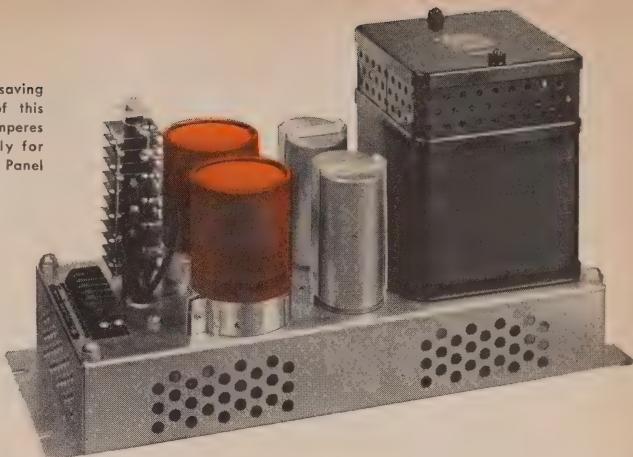
When the gate is in exact coincidence with the reference burst, the comparison circuit supplies no voltage to keep the phase shifter in rotation and the indicator remains fixed till some slight change in the course of the plane may activate the tracking circuits. The circuits then operate to indicate the changed bearing.

A somewhat analogous method is used in the distance-measuring equipment, with a pair of gates varying to tie in with signals having the same spacing as those sent from the plane. There is also a search and tracking mode, with a much lower interrogation pulse rate (approximately 24 per second) while tracking than during the search period when about 150 pulses per second are sent out. Circuit refinements in both the bearing and distance equipment add a "memory" to the circuits so that temporary interruptions of the signal, as by static, interference or the reference burst or identification signals do not return the equipment from the tracking to the search mode.

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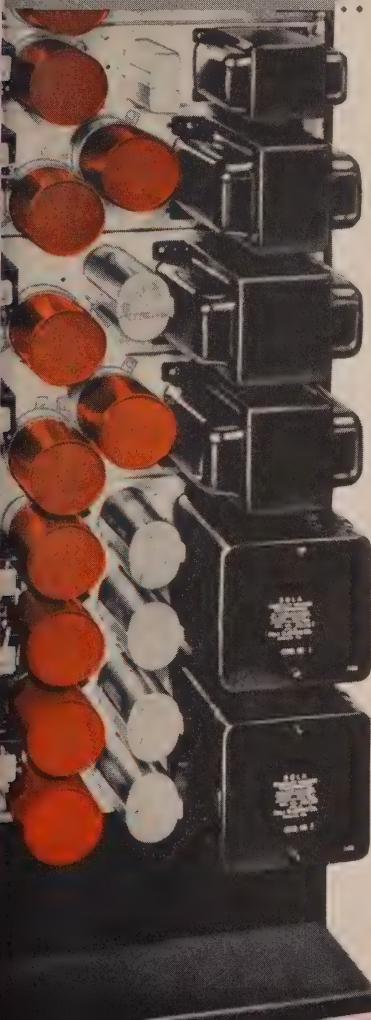


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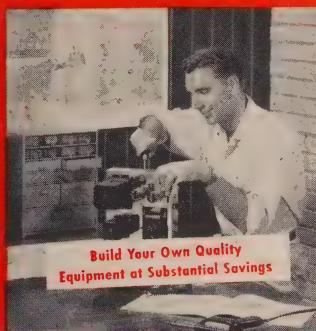
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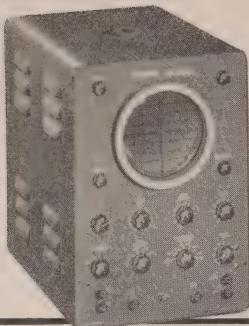
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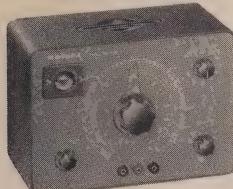
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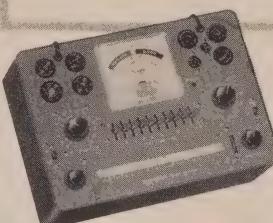
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Offers high accuracy, top versatility and convenience at lowest cost. Tests 4, 5, 6 and 7-pin large, regular and miniature types, octals, octalocats, 9-pin miniatures and pilot lamps. Features test for new 600 ma series string tubes. Tests for open, short, leakage, heater continuity and quality (by amount of cathode emission). 4½" square meter with clear "GOOD?-REPLACE" scale. With line-voltage indicator and line-adjust control. Choice of 14 filament voltages from .63 to 117 volts. Blank socket for future type tubes. Universal-type selector switches for any combination of pin connections. Single-unit, 10-lever function switch. Entire switch assembly is installed as a single unit—saves time and greatly simplifies construction. Illuminated roll chart lists over 600 tube types. Shpg. wt., 14 lbs.

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Model F-119. Cap. Checker Kit. \$12.50

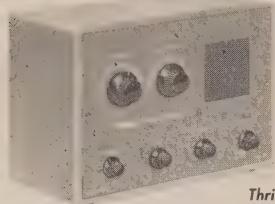
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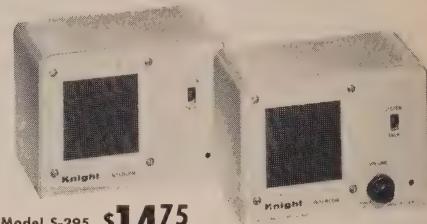
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S-247. Matching Cabinet for above. 2 lbs. Net.....\$2.90



Model S-295 \$14.75

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Model S-295. Two-Way Intercom Kit. Net only.....\$14.75



Model S-740 \$11.75

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"OCEAN HOPPER" RECEIVER KIT

Tops for exciting broadcast, long wave and short wave reception. Highly sensitive regenerative-type circuit. Excellent headphone reception; can be used with 3-4 ohm PM speaker or strong broadcast band stations. Supplied with plug-in coil for standard broadcast; covers long wave and popular short wave bands with coils below. Pulls in thrilling foreign broadcasts, police, amateurs and aircraft. Controls: Main Tuning, Bandspread, Antenna Tuning, Off-On-Regeneration. With all parts and tubes (less extra coils and headset). AC or DC. Shpg. wt., 5 lbs.

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EXTRA PLUG-IN COILS

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S-743. Short Wave, 2.9-7.3 mc.	Net.....	79¢
S-745. Short Wave, 7-17.5 mc.	Net.....	65¢
S-744. Short Wave, 15.5-35 mc.	Net.....	65¢



Model S-735 \$17.25

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"RANGER II" SUPERHET RADIO KIT

Thousands have built and enjoyed the "Ranger" Broadcast Band Receiver. Carefully engineered for easy construction and powerful, sensitive performance. Latest Superhet circuit; tunes 540 to 1680 kc; covers entire broadcast band and exciting police calls. Features automatic volume control, built-in preformed loop antenna, ball-bearing tuning condenser. Develops excellent tone quality from Alnico V PM dynamic speaker. Supplied with following tubes: 12SA7GT converter; 12SK7GT IF amp.; 12SQ7GT det.-AVC-audio; 50L6GT audio output; 3Z5GT rect. Complete with handsome brown plastic cabinet (6 x 9 x 5") tubes, speaker, all parts, and instruction manual. AC or DC operation.

Model S-735. "Ranger II" Superhet Radio Kit. Net only.....\$17.25



Model S-790

\$8.95

knight-kit LOW COST PHONO AMPLIFIER KIT

It's easy to build this fine-performing, low-cost compact phono amplifier. Ideal for use in a portable phonograph—simply add any

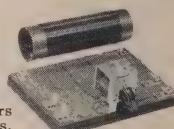
record player and a 3 to 4-ohm speaker. Amplifier works with crystal or ceramic cartridges. Inverse feedback circuit for rich, clean tone quality. Delivers full 1 1/2-watt output with less than .25 volt input. Includes efficient tone control; has AC outlet, controlled from amplifier switch. Complete with tubes and all parts. Size only 4 1/2" x 7" x 4"—fits into almost any portable phono case. Shpg. wt., 3 lbs.

Model S-790. Phono Amplifier Kit. Net only.....\$8.95

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Thousands of beginners have started in radio and electronics by building the KNIGHT-KIT crystal set. This feature-packed set delivers loud, clear reception of local broadcast stations. A germanium crystal diode detector assures high sensitivity and simple operation—no crystal adjustment required. "Hi-Q" coil boosts sensitivity. Ball-bearing variable capacitor for easy tuning. With all parts and simple-to-follow instructions. Shpg. wt., 1 lb.

Model S-261. Crystal Set Kit. Net only.....\$2.15
S-267. Accessory Kit. 2000-ohm headphones and all parts for outdoor antenna.....\$2.95



Model S-261

\$2.15

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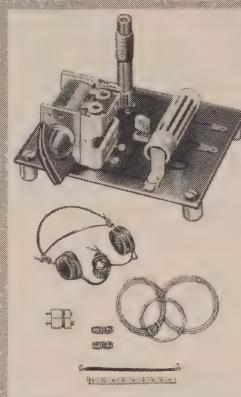
NEW knight-kit ELECTRONIC PHOTOFINISH KIT

Model S-244

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New feature-packed photoflash kit—designed for top quality dependability—available at a money-saving low price. Ideal for black and white or color photography. Xenon-filled reflector-bulb assembly gives over 10,000 flashes at less than $\frac{1}{2}$ cent each! 1/700-second flash freezes the fastest action. Has 50 watt-second output. Provides light approximating daylight in spectral quality; permits the use of outdoor-type film indoors. Film guide number for color (ASA10) is 45. Designed for "X" or "O" shutters only. Requires sync cable (available from any photo supply dealer) and either battery or AC supply listed below. Complete outfit with battery weighs only 3½ lbs. Kit includes all parts, carrying case and easy-to-follow instructions. Shpg. wt., 3 lbs.

Model S-244. Electronic Photoflash Kit. Net... \$28.50
S-246. AC Power Supply Kit. Easy to assemble... \$3.75
J-626. Battery for above (Burgess U-200)... \$8.47



knight-kit TRANSISTOR RADIO KIT

Printed Wiring • Works from Penlight Cell

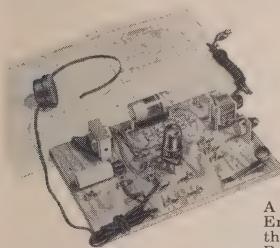
Model S-765

\$4.35

Smooth Variable Capacitor Tuning

Experiment with the marvel of transistors! Printed circuit requires no wiring—just assemble with a few solder connections and enjoy excellent reception over the full AM broadcast band. No tubes to burn out—no crystal. Compact—fits in the palm of your hand—operates for months from a single penlight cell. Transistor provides plenty of power for strong headphones reception. Complete with all parts, transistor and penlight cell. Shpg. wt., 8 oz.

Model S-765. Transistor Radio Kit **\$4.35**
S-266. Accessory Kit. 4000-ohm headphones and all parts for outdoor antenna.....
\$3.15



FAMOUS knight-kit LAB KITS

6-IN-1 RADIO LAB KIT

Model S-770

\$7.95

Build Any
of 6 Electronic
Projects

A fascinating and instructive kit. Enables you to build any one of the following projects: Standard Broadcast Receiver; Wireless "Home Broadcaster"; Code Practice Oscillator; Code Practice Broadcaster; Signal Tracer; Sine Wave Generator. Perfect for beginners. Once basic wiring is completed, circuits may be changed without soldering. Safe to build and operate; only tools needed are screwdriver, pliers and soldering iron. The ideal kit for students and beginners in electronics. Kit includes mounting board, tube, all parts and easy-to-follow instruction manual. Less headphone (also serves as mike). Shpg. wt., 6 lbs.

Model S-770. "6-in-1" Lab Kit. Net only..... \$7.95
J-112. Single 1000-ohm headphone for above..... \$1.05
C-100. Antenna kit for above..... \$1.05

10-IN-1 LAB KIT

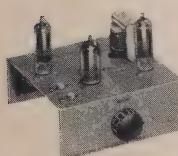
Model S-265

\$12.65

Build Any of
10 Electronic
Projects

A wonderfully instructive electronics kit. Ideal for experimenters, beginners—fun to build. Construct a sensitive Broadcast Receiver; Amplifier (for phone or mike); Wireless Phono Oscillator; Home "Broadcast Station"; Code Practice Oscillator; Capacity-Operated Relay, or any one of four other fascinating projects. Low voltages; safe to build and operate. Only tools needed are soldering iron, screwdriver and pliers. Perfect for self-instruction in circuit fundamentals, and packed with practical applications. Kit includes mounting board, tubes, all parts, hardware, microphone, and 12-page builders' manual. Shpg. wt., 10 lbs.

Model S-265. "10-in-1" Lab Kit. Net only..... \$12.65
J-112. Single 1000-ohm headphone for above..... \$1.05
C-100. Antenna Kit for above..... \$1.05



knight-kit WIRELESS BROADCASTER KIT

Model S-705

\$9.50

This fascinating unit makes it possible to "broadcast" with phonograph or microphone through any standard radio receiver up to 50 feet away—without any connection to the set. May be used with crystal or magnetic cartridge, or with microphone. Broadcasts a clear, full-toned signal. High-gain stage permits using magnetic cartridge without need for external preamp. Complete with all parts, tubes, wire and solder (less microphone). 4½ x 5 x 6". Easy to assemble. Shpg. wt., 3 lbs.

Model S-705. Wireless Broadcaster Kit. Net only..... \$9.50
S-556. Microphone for above with 5-ft. cable..... \$3.95



knight-kit PHONO OSCILLATOR KIT

Model S-760

\$5.85

This low-cost phono oscillator may be used with any crystal phonograph for "broadcasting" recorded music through any standard radio receiver up to 50 feet away. Requires no direct connection to radio set. Operates on any frequency between 600 and 800 kc. Has controls for adjustment of modulation level and selection of clear frequency on radio receiver. Uses 50L6GT tube and 35Z5GT rectifier. Complete with all parts, tubes and instructions. 4½ x 4¾ x 4½". Shpg. wt., 1 lb.

Model S-760. Phono Oscillator Kit. Net only..... \$5.85

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knight-kit CODE PRACTICE OSCILLATOR KIT

Model S-239 Transistor Circuit—

Powered by
Penlight Cell
\$3.95

An ideal code practice oscillator. Uses transistor circuit. Extremely low current consumption—powered by single penlight battery. Provides crisp, clear tone (400 to 600 cps). Has input jack for earphone; screw-type terminal strip for key. In compact bakelite case (2½ x 3¾ x 1½") with anodized aluminum panel. Complete with all parts, transistor, battery and easy-to-follow instructions. Shpg. wt., 1 lb.

Model S-239. Code Practice Kit.... \$3.95

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LINEAR-DELUXE
HI-FI AMPLIFIER KIT

Model S-755

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Williamson-Type Circuit
 Printed Circuit Board
 Chrome-Plated Chassis



This super-quality hi-fi basic amplifier is designed to satisfy the most critical listener. Intended for use with tuners incorporating built-in preamp, or with separate preamp. Incorporates latest Williamson-type circuit and features vacuum tube crossover. Frequency response is ± 0.5 db, 10 cps to 120 kc, measured at 20 watts. Harmonic distortion is only 1.5% right up to 30 watts. Intermodulation distortion is only .27% at 10 watts and only .4% at 20 watts, using 60 cps and 7 kc, 1:4 ratio. Hum level is -85 db below full rated output. Output impedance, 4, 8, 16 ohms. Input voltage for 25-watt output is 1.8 volts. Uses two 12AU7's, two 5881's, and a 5V4. Etched circuit is utilized in voltage amplifier and phase inverter stages to speed assembly. Has output tube balancing control, variable damping control, and on-off switch. Handsome chrome-plated chassis, 14 x 9 x 2". Overall height, 7". A deluxe true hi-fi amplifier equal in performance to amplifiers selling at over twice the price. Complete with all parts and tubes. Easy to assemble. Shpg. wt., 27 lbs.

Model S-755. Basic 25 Watt Hi-Fi Amplifier Kit. Net only \$44.50

Model S-759. Metal enclosure for above; black finish. 3 lbs. Net \$4.25



10-WATT HI-FI AMPLIFIER KIT

Model S-753

Chrome-Plated Chassis

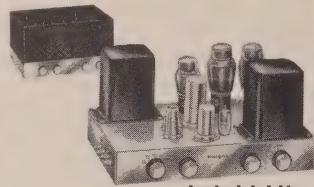
\$23.50

Famous for wide response and smooth reproduction at low cost. Only 0.5 volt drives amplifier to full output. Frequency response: ± 1 db, 30-20,000 cps at 10 watts. Harmonic distortion less than 0.5% at 10 watts. Intermod. distortion less than 1.5% at full output. Controls: on-off volume, bass, treble. Input for crystal phone or tuner. Chromed chassis; punched to accommodate magnetic cartridge preamp. Matches 8 ohm speakers. Shpg. wt., 14 lbs.

Model S-753. Amplifier Kit. Net only \$23.50

Model S-235. Preamp Kit for above \$3.10

Model S-757. Metal Enclosure. 3 lbs. \$3.95



20-WATT HI-FI AMPLIFIER KIT

Model S-750

Chrome-Plated Chassis

\$35.75

True hi-fi for less! Frequency response, ± 1 db, 20-20,000 cps at 20 watts. Distortion, 1% at 20 watts. Hum and noise level: tuner input, 90 db below 20 watts; phone 72 db below 20 watts. 4 to 100 ohm phono, microphone, crystal phono or recorder, and tuner. Controls: Bass, Treble, Volume, Selector. With compensation positions for 78 and LP records. Built-in Preamp. Outputs: 4, 8, 16 and 500 ohms, 23 lbs.

Model S-750. 20-Watt Kit. Net only \$35.75

Model S-758. Metal Enclosure. 3 lbs. \$4.15

Model S-752. Chrome-plated escutcheon for cabinet installation of amplifier. Net \$1.40

LOW-COST TOP QUALITY
KITS FOR THE HAM



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50-WATT CW TRANSMITTER KIT

Model S-255

\$43.75

Built-in Pi-Type Antenna Coupler

Check the features packed into this new transmitter kit and you'll see why it's one of the greatest Amateur values ever offered. Compact and versatile, it is the perfect transmitter for the beginning experimenter or seasoned veteran. Features: 50 watts input to 800, filament efficiency 6AG7 modified-Pierce oscillator takes crystal or VFO without circuit changes; bandswitching coverage of 40, 20, 15, 11-10 meters; pi-section antenna output matches line impedances from 50 to 1200 ohms—permits use with any type of antenna; no separate antenna tuner required. Crisp, clean, cathode keying of oscillator and final. Power take-off plug supplies filament and B-plus voltages for other equipment. Copper-finned heat sink and cabinet interior, filtering, shielding, bypassing, and optional SSB 230-meter converter provide excellent TVI suppression. Meters read either plate or grid current of final. Jacks for VFO, crystal and key. Supplied with all parts and tubes. Less crystal and key. 8 $\frac{1}{2}$ x 11 $\frac{1}{4}$ x 8 $\frac{3}{4}$ ". Shpg. wt., 18 lbs.

Model S-255. 50-Watt Transmitter Kit. Net \$43.75



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SELF-POWERED

VFO KIT

Model S-725

\$28.50

Complete with built-in power supply! Careful design and voltage regulation assure high stability. Excellent oscillator keying characteristics for fast break-in without clicks or chirps. Full TVI suppression. Has plenty of bandwidths selectable for 80, 40, 20, 15, 11 and 10 meters; vernier dial. Solid-state chassis construction keeps heat from frequency determining circuits. Output cable plug into crystal socket of transmitter. Output on 80 and 40 meters. With Spot-Off-Transmit switch for "no swish" tuning. Extra switch contacts for operating relays and other equipment. With all parts and tubes. 8 lbs.

Model S-725. Self-Powered VFO Kit. Net \$28.50

NEW knight-kit
AMATEUR RF
"Z" BRIDGE KIT

Model S-253
\$5.85

Measures standing wave ratio (SWR) and impedance of antenna systems; also for adjusting antenna networks for optimum results. Any VOM may be used. High accuracy, 20,000 ohm/volt scale. With coax input and output connectors. Meters both input and bridge voltage. Calibrated dial gives direct impedance reading; includes 1% precision resistor for precise calibration adjustment. With all parts and hard plasticized SWR chart. 1 $\frac{1}{2}$ lbs.

Model S-253. "Z" Bridge Kit. Net only \$5.85

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TRANSISTOR RADIOS

Part VI—Interesting recent offerings by RCA, Westinghouse, Emerson, Philco and Bulova

By I. QUEEN
EDITORIAL ASSOCIATE

THE latest n-p-n grown junction transistors are being made with very low internal collector capacitance. Furthermore, these units can be made nearly identical so far as capacitance is concerned. A typical value is $2 \mu\text{uf}$. Because of this extremely low capacitance, neutralization can be dispensed with. Of course, the circuit wiring and parts placement must be designed to eliminate all external feedback from output to input. This feedback balance must not be disturbed through any changes in wiring or parts placement when being serviced. Replacement of transistors with different types may upset either the gain or capacitance balance, causing either regeneration or degeneration and affecting the optimum performance of the set. With the exception of the Philco and Bulova, the sets below do not require neutralization.

RCA 7-BT-9J

This receiver (Fig. 1) uses six transistors, three n-p-n types in the high-frequency circuits and three p-n-p units for audio. The set measures $3\frac{7}{16} \times 5\frac{13}{16} \times 1\frac{9}{16}$ inches and weighs 1 pound with battery. Output is 65 mw undistorted, with a maximum of 100 mw. It has a printed circuit, and the cabinet is made of nonbreakable Impac plastic.

The signal and local oscillator frequencies are mixed by connecting in series the secondaries of the oscillator transformer and the antenna loop. It is desirable to stabilize the bias for a converter. This is often done by a voltage divider. Here, the V1 base is returned to a point of fixed positive voltage, the emitter of V2. Minus the small drop in R1, it provides a low bias for the converter.

As usual, the signal is impressed across the emitter-base circuit of each if stage (through a capacitor). However, the collector circuits are not conventional. Ordinarily, these return (through a capacitor) to the emitters. This receiver returns them to a *center tap* on the transformer secondary. This means that the if amplifiers function more like *common-base* stages which are highly degenerative and require no neutralization. Since the center taps

are between emitter and base in each case, each stage is actually a compromise between common emitter and common base. There is sufficient degeneration to make neutralization unnecessary, yet ample gain remains.

The detector diode generates a negative potential across the volume control. This is filtered and fed back to the base of V2. A strong signal reduces the gain for proper avc action.

The push-pull class-B stage includes a thermistor whose resistance is 270 ohms at normal room temperature. When the set is operated in a warm location, the transistors are more conductive and pass greater current. At the same time, the thermistor resistance goes down (due to the higher temperature) and lowers the potential between base and emitter. One effect offsets the other, so the class-B current remains nearly constant regardless of temperature variation.

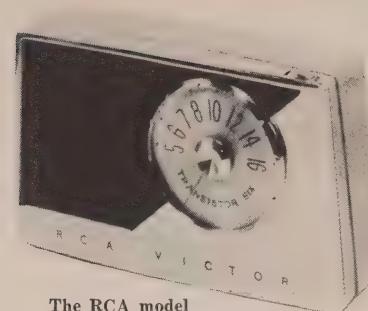
The no-signal current to this receiver is 6 ma, at 50-mw output, it rises to 14 ma.

Westinghouse "Seven Transistor"

This set has a $6 \times 3\frac{1}{8} \times 1\frac{1}{8}$ -inch unbreakable case (choice of three colors) that fits a lady's handbag or a man's suit pocket. It features a printed-board circuit and class-B output driving a $2\frac{3}{4}$ -inch speaker (Fig. 2), weight is $15\frac{1}{2}$ ounces. Conelrad frequencies are identified. An earphone jack is included for personal listening. Power supply is a 9-volt battery, drain on which is only 5 ma at low volume.

The high-frequency circuits use n-p-n transistors; the audio stages are p-n-p. The converter is the usual autodyne which combines oscillation and mixing. Oscillation results from inductive coupling between the converter's emitter and collector circuits.

The if stages do not provide for neutralization but the following must be observed: Both stages may use a 2N146 transistor type or the first may use a 2N145 and the second a 2N147. Otherwise, gain or feedback balance may be upset. Each transformer is untapped and the bases are biased from a fixed resistor network. The detector



The RCA model
7-BT-9J

is a class-B stage that amplifies as well as rectifies.

The avc system deserves special comment. The detector passes more current as the signal strength increases. This current must flow through R6 (in the first if stage). Thus, as the current rises with greater signal, R6 biases its if amplifier for less gain. A large capacitor is used across R6 to filter the variations so that gain will not be controlled from one instant to the next but, rather, smoothly over an extended interval.

The volume control is a potentiometer that determines the fraction of output transferred to the driver. When its arm—connected to the detector output—is set at the low end of the control, no audio is transferred. At the high end, all audio is fed to the driver.

When an earpiece is plugged into the jack (driver stage), the class-B stage is disconnected from the driver. Note, however, that its power is not cut off. A class-B stage consumes power in proportion to its signal input. Naturally there is no signal input when the earpiece is plugged in. Thus the stage idles and consumes negligible power. The output stage requires a matched pair of transistors and is fixed-biased. The speaker impedance is 12 ohms.

Emerson model 855

This receiver measures $9\frac{3}{8} \times 7 \times 3\frac{5}{16}$ inches and weighs 5 pounds with batteries. Leather cabinets (choice of five colors) are available for it. The set is powered by a pair of 9-volt batteries in parallel (Eveready 276 or equivalent). These will operate the receiver up to 1,500 hours, that is, 2 to 5 years of normal playing. Operating cost is actually less than that of an ac radio.

Fig. 3 shows the schematic and the voltages at transistor elements with respect to chassis. The converter is conventional. It feeds into a pair of if stages that require no neutralization. These stages are peaked at 455 kc as usual. Each transistor may be a 2N146 or the first stage may be 2N145 and the second 2N147. Each base and collector is properly bypassed as shown.



a—Philco model T7; b—Bulova series 270; c—Emerson 855 and d—Westinghouse Seven Transistor.

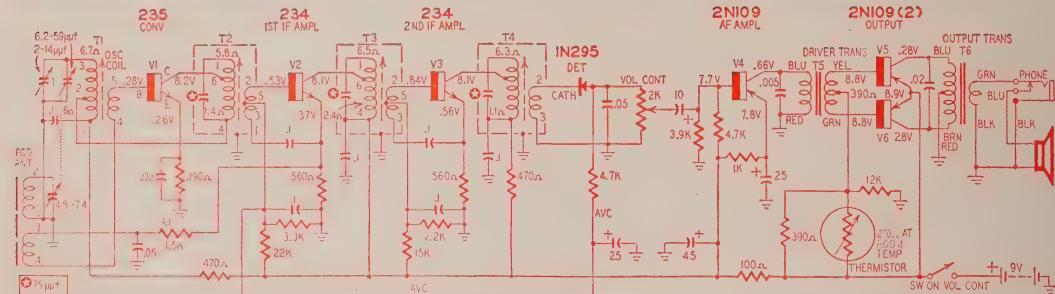


Fig. 1.—The RCA 7-BT-9J. Some interesting if features are to be found in this six-transistor, one-diode radio.

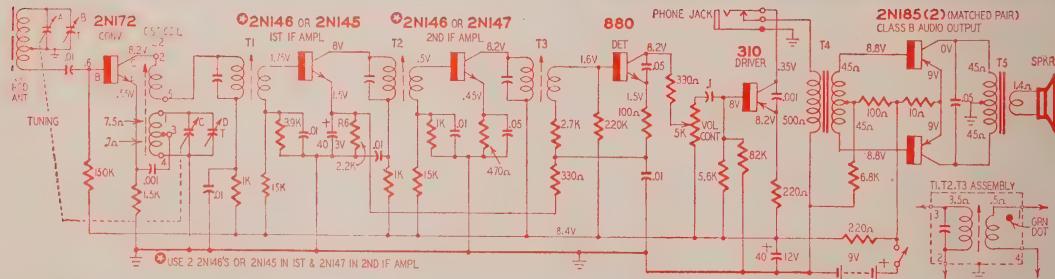


Fig. 2.—The Westinghouse Seven Transistor receiver uses n-p-n transistors in the rf circuits, p-n-p's in the audio stages.

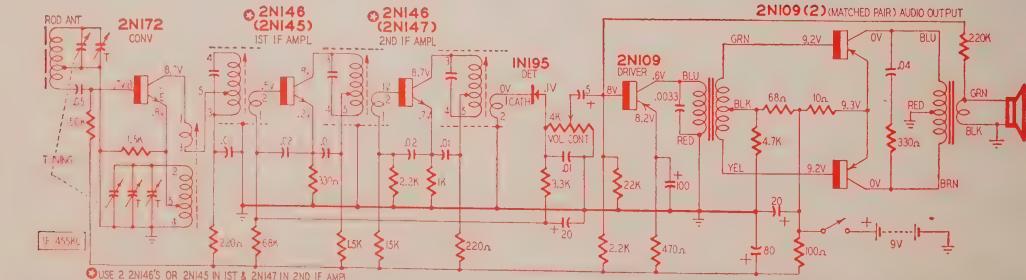


Fig. 3.—The Emerson model 855, another six-transistor-plus-diode receiver has a pair of 9-volt batteries in parallel.

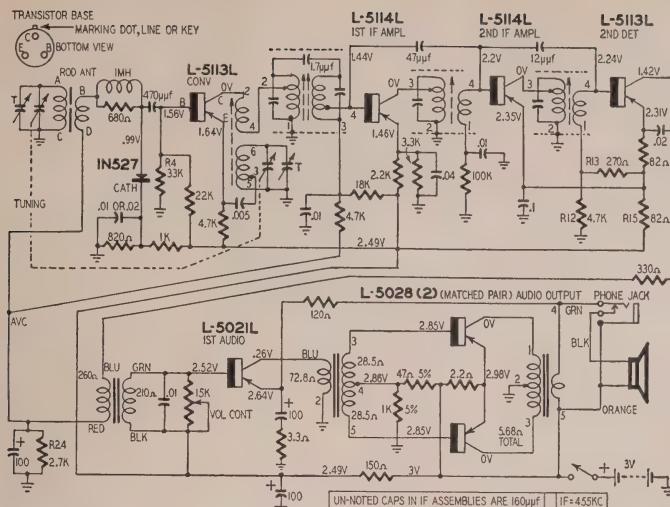


Fig. 4—The Philco Cordless T is a seven-transistor set that operates from only 3 volts. It uses neutralization.

Unbypassed emitters provide a small amount of degeneration for stability.

The detector is a crystal diode. It supplies a negative voltage to the volume control. The ac component is fed through a 5- μ f capacitor to the driver. The dc component (across the volume control) is filtered and fed back to the base of the first if. This constitutes the avc action. A stronger signal will generate a greater dc voltage at the volume control. This negative potential will bias the if stage to lower gain.

The driver is fixed-bias. It feeds an also fixed-bias class-B stage. This output stage is fed directly from the battery, all previous transistors being supplied through a filter resistor (100 ohms). Tone from this set is enhanced by a degenerative network that couples the speaker to the base of the driver. Also, a tone network is included across the primary of the output transformer.

Philco Cordless T7

This receiver measures 7 x 4½ x 2 inches. Its nonbreakable cabinet is made of high-impact plastic. Components are mounted on a printed-wire panel.

The Philco is very unusual in that its power supply consists of just a pair of size-D flashlight cells. These cost about 25c and can power the set for approx-

imately 250 hours. This extended life is made possible through the use of surface-barrier transistors in the high-frequency stages. Surface-barrier units require very low current and voltage yet are highly efficient at high frequencies. The audio stages use alloy junction transistors which require (and deliver) higher power than the barrier types. (See Fig. 4.)

The unconventional input stage utilizes a crystal diode to aid a.v.c. action. The a.v.c. supply is in series with the secondary of the loop antenna. As a.v.c. voltage goes more positive due to stronger signals, it biases the diode to greater conduction. Thus the diode partially "shorts" the signal and reduces its amplitude. An impedance network consisting of a 680-ohm resistor and a 1-millihenry coil in parallel helps to maintain constant response over the entire band.

The first if transformer is double-tuned to obtain a better flat-top response. The first if stage is biased from the avc lead. As the avc goes more positive with increasing signal, it reduces the if gain. Both if stages are neutralized.

The detector is biased to cutoff by R12, R13. Therefore its collector current increases in proportion to signal.

This current flows through the primary of the first audio transformer and through R24. A large capacitor filters this current, and delivers the drop across R24 as ave voltage to the converter and first if.

With zero signal, the detector must remain near cutoff but this optimum bias may change due to temperature variations. To guard against this, R15 is connected to pass currents of both the second if and the detector emitters. Assume a temperature rise so that both emitter currents tend to increase. Now the greater current of the second if amplifier will produce a drop across R15. This tends to reduce (and thus cancel) the original rise in detector current due to temperature. Note that the second if is not supplied by avc so its emitter current is essentially constant, except for temperature effects.

The audio stages are transformer-coupled. The volume control shunts the first transformer and controls the input to the first stage. Emitter bias for this transistor is supplied through the output transformer (see diagram). This network also supplies degenerative feedback to the first audio stage for tone quality. The output class-B stage is biased by 5% resistors.

Bulova series 270

These receivers measure 3 $\frac{3}{8}$ x 6 $\frac{1}{8}$ x 1 $\frac{1}{4}$ inches and weigh 22 ounces. Cabinet is available in choice of two colors—mahogany alligator (model 270) and sun-tan alligator (model 277). Both are unbreakable. The set has its own leather type handle and does not need a carrying case. A single 9-volt battery provides 950 hours of playing time. The radio is guaranteed for a year, the transistors for life.

Using only four transistors and a diode detector, model 270 gives excellent results. The mixer-oscillator feeds into a single if stage. A 10- μ f capacitor neutralizes the stage by feeding back energy in opposite phase to that which passes directly through the transistor.

The detector generates a positive voltage which is filtered and applied to the if stage as avc. A transformer couples the audio stages. The output is single-ended as shown in Fig. 5.

Bulova also manufactures a deluxe portable using six transistors and a diode. Model 267 has a 4-inch speaker, provides 500 hours of playing time from a single 9-volt battery, is 5% x 6½ x 2½ inches. TO BE CONTINUED

TO BE CONTINUED

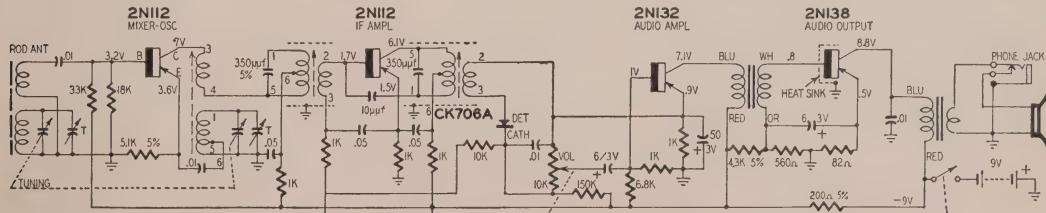
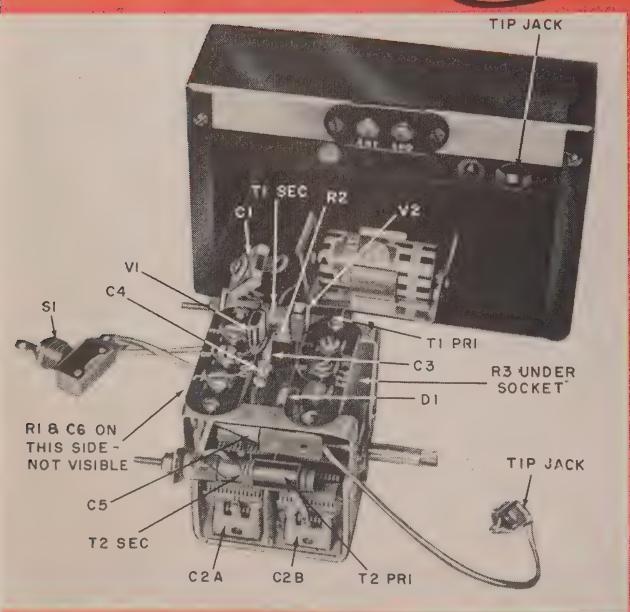


Fig. 5. Growth rates of the initial polymer and of some later polymer.

TRANSISTORIZED RADIO HAS

RF STAGE



Chassis view. Components are mounted on strips bolted to the capacitor.

By J. E. PUGH, JR.

A SINGLE-STAGE transistorized rf amplifier ahead of the now-popular radios consisting of a crystal detector and a transistorized audio amplifier will improve both sensitivity and selectivity at a small cost.

Such an amplifier is made practical by the high alpha cutoff-frequency transistors now available at prices attractive to the experimenter. Several such rf transistors can be obtained but the Raytheon CK760 (2N112) was selected for the receiver to be described. This transistor has an alpha cutoff frequency of 5 mc with a theoretical maximum gain of 20 db at 2 mc, which is adequate for good results over the entire broadcast band.

The antenna is coupled to T1-C2-a (Fig. 1), the first resonant circuit, through C1, the antenna trimmer capacitor. This capacitor is adjustable from 45 to 380 μpf and permits the receiver to be used with a wide range of antenna lengths. Both T1 and T2 are high-Q inductors with adjustable ferrite cores. An extra coil is wound on each inductor on T1 to match the low input impedance of V1 to the high impedance of T1-C2-a; on T2 to provide neutralization voltage through C4 for the rf amplifier stage. Capacitor C2 is a 10-365- μuf two-gang variable capacitor and has just enough capacitance variation to cover the broadcast band from 550 to 1500 kc.

Transistor V1 is connected in a grounded-emitter circuit with R2 being used to give a slight increase in input impedance. Resistor R1 is of such a value as to limit V1 collector current to below 1 milliampere.

The signal is rectified in the crystal diode detector D1 and the audio component is amplified by transistor V2. The load for this amplifier is a pair of 24,000-ohm magnetic headphones, which is well suited to this purpose as the majority of grounded-emitter amplifiers require a load impedance of 20,000 to 30,000 ohms.

A single 1.5-volt flashlight cell supplies operating voltage. This voltage can be increased if desired but it should not be greater than 6 volts, as this is the absolute maximum collector-voltage

rating for the type CK760 transistor. The rf amplifier is designed to give a good balance between maximum selectivity and maximum sensitivity, and the overall result is very satisfactory for a receiver of this type. The selectivity is sufficient to give good separation in all cases except very close locals which may spread out enough to cover some weak distant stations. The sensitivity is great enough to make daytime reception of a station 250 miles away possible, and at night a station 1,100 miles away is received with good volume using a 10-foot antenna.

The output is great enough to drive a transistorized class-B amplifier if it is desirable to use a speaker instead of the headphones. Such an amplifier was described on page 59 of the March, 1956, issue of *RADIO-ELECTRONICS* and, if it is used, a volume control should be added between D1 and V2.

Construction details

A $4 \times 4\frac{1}{4} \times 6$ -inch sloping-panel metal cabinet is used to house the receiver. It is fairly large to keep the losses in the high-Q inductors, T1 and T2, at a minimum. If a nonmetallic cabinet is used, it can be much smaller.

The two three-lug screw type terminal strips used for transistor sockets are mounted on an aluminum strip framework screwed to the front and back surfaces of the tuning capacitor frame. The holes for mounting these strips and for fastening the capacitor to the cabinet are tapped so the 6-32 mounting screws do not project beyond the inner surface of the capacitor frame. Since most of the small parts are mounted on the underside of the terminal strips, ample space must be allowed for clearance between them and the opened rotor plates on the tuning capacitor.

Transformers T1 and T2 are Grayburne Vari-Loopsticks. This type coil is adjustable with a screw-actuated core and is supplied with an 18-inch length of wire attached to one terminal. This length of wire is used for the secondary and is closewound in either direction for 17 or 18 turns with a

spacing of $\frac{1}{8}$ inch below the bottom of L1. The L2 secondary is closewound snugly against the bottom of and in the same direction as the primary for 17 or 18 turns. When wound in the correct direction, this secondary will appear as a continuation of the primary winding with the ground tap at their junction. It can be fastened with coil dope after it is wound. The T1 secondary should not be cemented at this time as it may need a slight adjustment during the alignment procedure. After the secondaries are wound the mounting brackets supplied with these coils can be cut off, drilled and mounted on the capacitor.

The antenna trimmer C1 is soldered directly to the "hot" lug of T1 and is connected to the antenna terminal with a short length of No. 16 wire, which provides a rigid support for C1. It is first soldered to the antenna terminal and is then soldered to C1 after the receiver assembly is mounted inside the cabinet.

Rubber feet ($\frac{1}{8}$ -inch od) can be mounted on the bottom of the cabinet to improve the appearance and to prevent scratching the furniture.

Alignment

The first step in the alignment procedure is to put the calibration marks on the panel, using the template in Fig. 2. These lines can be made by scratching through the paint carefully with a sharp pointed tool such as a machinist's scriber, or decals can be used for both the calibration lines and numerals.

After the dial marking is completed, a few preliminary adjustments can be made. First adjust both T1 and T2 until the top of the core is about even with the top of the primary winding. Next back the antenna trimmer off about 1 turn from maximum capacitance and then back off the trimmers on both sections of C2 about $1\frac{1}{2}$ turns. After the above adjustments have been made, the receiver can be mounted in the cabinet. At this time it should be possible to receive stations but the following adjustments must be made for peak performance:

1. Connect a modulated signal gen-

Parts list for trf-stage receiver

B1—1.5-volt flashlight cell-type C	Phones—Headphones, Trimmable
C1—45-380 μ uf, mica, trimmer	24,000-ohm Featherweight
C2—10-365 μ uf, 2-gang, variable, with trimmers—Miller 2112 or	24,000-ohm
C3—1,000 μ uf, ceramic	R1—100 ohms
C4—33 μ uf, ceramic	R2—100 ohms
C5, C6—0.01 μ f, molded plastic	R3—220,000 ohms
D1—IN34 crystal diode	All resistors $1\frac{1}{2}$ watt
T1, T2—Grayburne Vari-Loopstick (see text)	S-spst toggle switch
	V1—CK760 (2N112) transistor
	V2—CK722 transistor
	3-screw terminal strips (2)
	2-screw terminal strip
	2-1/16-inch-diameter, skirted knob
	4 \times $4\frac{1}{4} \times 6$ -inch sloping-panel cabinet
	Acme No. 9
	Battery box—Austin Craft I-C or
	I-terminal tie-point lug
	Phone jack or tip jacks
	Miscellaneous screws, nuts, washers, etc.

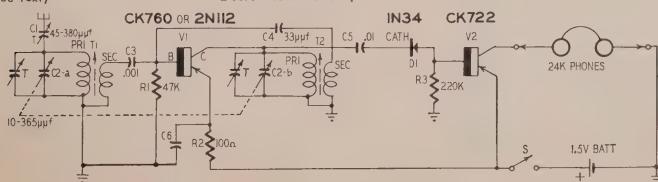


Fig. 1—The receiver uses two transistors plus a crystal diode detector.

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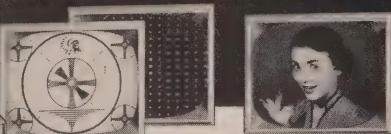


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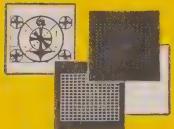
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erator to the input terminals of the receiver and an oscilloscope or ac voltmeter across the headphones.

2. Set the generator and the receiver dial to 600 kc.

3. Adjust core of T1 for maximum output.

4. Adjust core of T2 for maximum output.

5. Set the generator and the receiver dial to 1400 kc.

6. Adjust C2-a trimmer for maximum output.

7. Adjust C2-b trimmer for maximum output.

8. Repeat steps 2 to 7 until the output is peaked at 600 and 1400 kc. Since there is some interaction between the input and output circuits of V1, these adjustments will need to be repeated several times before best tracking is obtained. If there is any tendency to oscillate during alignment, back L2 off from T1 slightly.

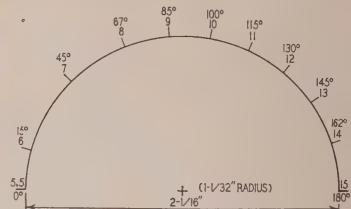


Fig. 2.—Template for the dial layout

9. Disconnect the signal generator and connect the antenna and ground to the receiver. A 1400-kc signal is now induced into the antenna by attaching a short antenna to the signal generator. Now adjust the antenna trimmer for maximum output at a dial setting of 1400 kc and the receiver is ready to use.

If a signal generator is not available, make the alignment as follows:

1. First make the preliminary alignment as described above and then determine the exact frequency of two nearby broadcast stations. One should be between 550 to 750 kc and the other between 1200 and 1500 kc.

2. Connect the antenna and ground leads to the receiver.

3. Set the dial to read the same frequency as lower-frequency station.

4. Adjust T1 and then T2 for maximum output.

5. Set the dial to read the same as the higher-frequency station.

6. Adjust the antenna trimmer and then the C2-b trimmer for maximum output.

7. Repeat steps 3, 4, 5 and 6 until both stations are loudest at the correct dial readings.

If the antenna length is ever changed, readjust the antenna trimmer for maximum output with the receiver dial set at 1400 kc. This can be done without the signal generator if a station of known frequency between 1200 to 1500 kc is available. Simply set the receiver dial to read the same as the transmitter frequency and adjust the C2-a trimmer for maximum output. END

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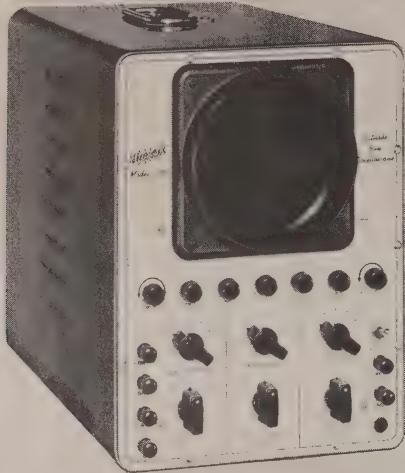
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Improving Sensitivity in AC-DC Radios

By CHARLES GARRETT

MANY of the small ac-dc radios brought to repair shops have poor sensitivity at the low-frequency end of the dial (550-800 kc). But because these radios usually have only an oscillator trimmer, and rarely a padder, the service technician generally is helpless to improve their low-end response. The following suggestions will improve the majority of such radios.

On radios with the conventional flat-loop type antenna, try this: Tune to a station around 1400 kc and peak the antenna trimmer (it is usually mounted along with the oscillator trimmer on the side of the tuning gang). Then tune to a weak station near 600 kc and adjust the oscillator trimmer in and out for peak reception while rocking the tuning gang back and forth to hold in the station.

Recheck the antenna trimmer again at 1400 kc and then for best results repeat the procedure at least once.

The dial pointer may now indicate slightly off the received station but due to the vague dial markings on most of today's radios, this is not always important. If it is necessary to set the dial pointer accurately on any particular radio, move the *pointer* and do not adjust the oscillator trimmer again or the low-end response will suffer. In some extreme cases, a compromise between accurate dial settings and low-end sensitivity may become a necessity.

Radios using small pencil-shaped antennas (a powdered-iron core with a few loose turns of wire wound on it) can be peaked at both low and high ends without affecting dial accuracy in any way by using the following methods:

First, only a small percentage of these types of antennas provide for adjusting the core for peak low-end response. On these few adjust the antenna trimmer at about 1400 kc and the *core* at about 600 kc. Repeat the procedure at least once.

If those that are not adjustable, two types are available. One is short,



Fig. 1—The core is loosened and slipped in and out for peak results at 600 kc.



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about 3 inches, and its coil is wound on a paper coil form with the powdered-iron core cemented inside the form. To align this type, first free the core (Fig. 1) by applying G-C Service Solvent or a similar solvent to the cemented areas. Set the dial on a weak station around 600 kc and move the core in or out of the coil form to the point of peak reception. Adjust the antenna trimmer at the 1400-kc end, repeat the procedure at least once and then cement the core in place.

The other type of rod antenna is about 6 inches long and 0.5 inch across. Its coil is cemented or waxed directly on the core in loosely separated turns except at one end where the coil bunches.

Loosen the bunched section of the coil (Fig. 2) with service solvent, if

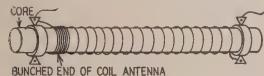


Fig. 2—Bunched end of antenna coil is slid back and forth for peak reception at the low end of the band—600 kc.

necessary, and with the set tuned to a station near 600 kc gently slide that part of the coil back and forth for peak reception. Trim on the high end as usual and repeat the procedure for best results.

Be sure—before starting to work on the receiver—that it is already working at its highest sensitivity. Test all the tubes and make sure that the set is properly aligned.

There is one more problem concerning receiver sensitivity. Occasionally poor sensitivity in a particular receiver is caused by the necessity of mistuning the if transformers to prevent oscillating or squealing. In a case like this try reversing the leads attached to the terminals of either the primary or secondary of either, or both, of the if transformers. Then realign. The resulting improvement in low-end response should be most gratifying. END



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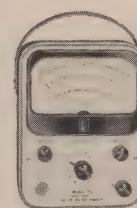
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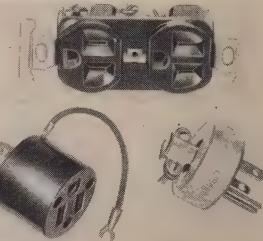
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PURCHASERS of new portable electric drills, sanders, saws, impact hammers and similar tools will probably find them fitted with a 3-prong power plug that will not fit into a standard receptacle. This third prong replaces the seldom-used pigtail ground lead formerly supplied on portable electrical equipment. The pigtail did not make grounding mandatory so the use of a 3-wire line and 3-prong plug was recommended by Underwriters Laboratories and adopted by most manufacturers of portable electric tools. This trend is expected gradually to extend to household appliances.



New 3-wire duplex receptacle with adapter and matching plug below

The reason for grounding such tools and equipment is a sound one. If the hot side of the power line should short to the motor frame or metal shell of the equipment, the operator is likely to receive a fatal shock. On the other hand, if the frame of the equipment is grounded, a fuse will blow.

To use these tools, you will either have to replace the conventional convenience outlet with a new 3-wire parallel-slot grounding type receptacle or use an adapter between the 2-prong receptacle and the 3-prong plug. (See photo.) The adapter has a grounding pigtail with a lug for fastening to a screw on the receptacle's wall plate or cover. The 3-prong adapter and receptacle will also accommodate regular and polarized plugs used on equipment that does not require grounding.

Either an adapter or a 3-wire parallel-blade grounding receptacle should be installed permanently at all outlets where new power tools are likely to be used. An adapter and a 3-wire extension cord with grounding type male and female connectors should always be carried along with the tool on jobs outside the shop because matching convenience receptacles are not likely to be available.

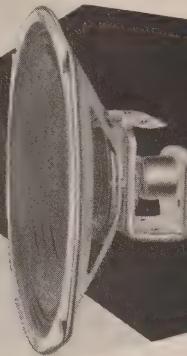
Tools equipped with pigtail grounding leads can be readily converted by clipping off the molded rubber plug and replacing it with a 3-wire parallel-blade type. Older tools not equipped for grounding can be made much safer to use by replacing the line cords with a 3-wire line with the same size conductors. The third conductor should be firmly connected to the ground lug in the plug at one end and to the frame of the motor at the other.

END

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Note: Records below are 12-inch LP and play back with RIAA curve unless otherwise indicated.

Boston Pops Picnic

Arthur Fiedler conducting the
Boston Pops Orchestra

RCA Victor IM-1985

This sounds very much as if RCA engineers have been listening to the Vanguard recordings of the Vienna State Opera Orchestra playing Strauss. Forgiving one or two slight lapses in monitoring which result in just a touch of distortion in a couple of spots and which place it just a shade under the above Capitol recording, this is in very much the same class and well worth the investment.

Mason's *Pops Polka* (band 1, side 1) has a brass-band flavor and sharpness with a lovely low dull drum and fine high highs. In fact, the drums takes its place beside that of the Vienna State Opera as a test of very fine speaker systems—on the best of them it has a lovely thud. The music, which should be a real picnic for the average hi-fi listener, includes the *Waltzing Cat*, *Jealousy*, *Danube Waves Waltz*, *Malagueña*, *Village Swallows Waltz* (complete with water whistle), *In a Persian Garden* and *Poet and Peasant*. The last is a very spectacular showoff with several really fortissimo peaks. Fiedler and the Pops play it with charming picninclike good humor and sprightliness.

This apparently was recorded at least 10 db below the standard peak level. In fact, tape recorder noise is audible in spots; thus there is only a second or two of overcutting distortion. The sound is impressive throughout and the balance is the best RCA has managed for this orchestra.

STRAUSS, JOHANN, JR.:
Le Beau Danube (Ballet)
Orchestra of the Paris Opera
conducted by Manuel Rosenthal

Capitol P-18006

The Paris Opera Orchestra seems to get better with each recording. This has an especially gorgeous sound with a nice dull bass—very big in spots—and bright high highs in excellent balance. The bass is not exaggerated, the high highs are always in proper perspective. Fortissimo in spots, but pianissimo in others, there is an excellent measure of both ends of the dynamic range. Apparently, every pops orchestra is now buying a big bass drum or digging one out of the attic; this one ranks with the Vienna State Opera's and the Boston Pops'. The music is a long medley of Strauss tunes strung together into a ballet and everybody but those who can no longer stand the *Blue Danube* should like it.

MOZART: Violin Concertos Nos. 4 and 5
Yehudi Menuhin, violin
Philharmonic Orchestra conducted by
John Pritchard

RCA Victor IM-1961

If, of the current anniversary flood of Mozart recordings, I were to recommend one as the most certain to please the most people, I think this would be it. The music is entirely delightful and Menuhin does it complete justice (though his own cadenzas are just a trifle too modern) in

a very natural fiddle tone, round in the high end and nicely gutting in the low end. There are some good examples of plucking, fingering and bowing transients (especially in No. 5). The orchestra contributes an excellent background with a nice bass. The second movement of No. 4 is one of the loveliest of violin solos.

SIBELIUS: Masterpieces

Arthur Winegrad String Orchestra
London Symphony Orchestra
Royal Opera House Orchestra
(Covent Garden)

MGM E-3332

Except for a few seconds of overcut distortion, this is another very fine example of excellent modern sound. It presents most of the popular Sibelius short pieces: *Finlandia*, *The Swan of Tuonela*, *Valse Triste*, *Festive, Romance* in C Major and *Rakastava*, in performances which seem adequate and with considerable material for testing and demonstration. Those who would like to add a potpourri of Sibelius will find this fills the bill pleasantly.

RACHMANINOFF: The Bells Symphony
Rome Symphony and Chorus, plus
soloists, conducted by Jacques
Rachmirevich

Supervised by Rachmaninoff Society

MGM E-3246

This was Rachmaninoff's *magnum opus*, and it puts soloists, chorus and orchestra through a lot of paces. It's considerable Rachmaninoff to take at one sitting, but if you go for him this is an adequate performance both musically and in sound.

SCHUMAN: Davidsbundler Dances
Symphonic Etudes

Capitol P-8337

These solo piano works are just enough out of the way to please those who are a little surfeited with the standard repertoire but not up to anything really esoteric. Pleasant and interesting music well played and again recorded just below the top for piano quality.

SHOSTAKOVICH: Six Preludes and
Fugues
Shostakovich, pianist

Capitol P-18013

The Russians may be catching up with us in atomic science and planes but they've got a long way to go in recording, though I admit I've heard worse recordings with strictly American labels and very recently released ones. This is definitely for those who are interested in technical aspects of music or who need the very esoteric to relieve their boredom. It is supposed to be Shostakovich's attempt to approach in a modern idiom the job Bach did with the *Well-Tempered Clavichord*. If anyone has had any doubts about whether the USSR's fair-haired boy of music stacks up to the old masters, this ought to dispel them. For my money he could just about hold the candle for a half-awake Bach improvising at a 4 o'clock mass. Still, this is a pretty fair effort and with considerable in-

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Here is an excerpt from a letter that we received from Loren DePrest, 1496 4th St., Mansfield, Ohio: "I have spent many pleasant hours in constructing the radios from the schematics in your book, and have learned a great deal from them. Being as I am interested in Radio, I consider the money spent for your course as a wise investment. I have learned more from your course by actually doing than I did from an expensive course."

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Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my 'Edu-Kit' and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Troubleshooting Tester that comes with the Kit is really swell, and finds the trouble if there is any to be found."

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NEW RECORDS

(Continued)

terest. Those who like to have versions played or conducted by the composers themselves should latch onto a copy of it.

RESPIGHI: *Roman Festivals*KODALY: *Háry János Suite*

Toscanini conducting the NBC

Symphony Orchestra

RCA Victor IM-1973

It is unfortunate that one of the world's most phenomenal conductors will be heard by posterity in recordings which do neither him nor the art of recording even token justice. Offhand I can think only of his recording of Mousorgsky's *Pictures at an Exhibition* as worthy of inclusion among the best examples of high-fidelity recordings. This recording shows what I mean. It is strictly for Toscanini adorers (and then to be played on a system that cuts off at about 5,000 cycles).

I was especially disappointed because Toscanini was perhaps the best interpreter of Respighi's music, and *Roman Festivals* is one of the most sensational sound-effect creations of that remarkable composer. You'd never know it from this recording, however. It is not only full of distortion, but with the most execrable balance of tone and so lacking in definition that it might almost be equally well played on a two-manual organ.

Háry János is among the most delightful of "modern" music, but this recording of a broadcast of 1947 is no better than a prewar shellac. Therefore, unless you collect Toscanini and your ears can overlook some frightful sound, you'll find versions by lesser conductors under other labels a far better buy. To do RCA Victor justice, I imagine they look upon this as a sort of archivistic recording, intended for collectors of of archival music.

PAGANINI: *Violin Concerto No. 1*
Fistoulari conducting the London SymphonySIBELIUS: *Violin Concerto in D Minor*
Boule conducting the London Philharmonic
Yehudi Menuhin, violinist

RCA Victor LM-1946

Menuhin is a violinist no record library can possibly overlook and this is a particularly happy example of his style. The Paganini is possibly the most suitable of all violin concertos for show-off and demonstration because—aside from some of the most brilliant fiddling fireworks—the accompanying orchestra, when giving the soloist a chance to wipe his brow or retune his fiddle, has some fine bass and cymbal high highs. The fiddle part calls for real virtuosity and is most melodic. The Sibelius presents an excellent contrast in orchestration and violin as well. It has some good kettle drums and basses and some very notable peaks and sharp brasses. Menuhin is very fine though he seems a little more bored with the Paganini that he was when Victor first recorded him in this before the war.

STRAUSS, Richard: *Metamorphoses Four Last Songs*
(Christel Goltz, soprano)
Hollreiser and Pro Musica Orchestra of Vienna

Vox PL-9400

If you have a hi-fi Golden Ear snob in the neighborhood who claims to hear all sorts of things you don't, try this on him. The *Metamorphoses* is a rather dull work which gives each of 10 violins, 5 violas, 5 cellos and 3 double basses an opportunity to play the lead or solo. Theoretically, all the instruments should be slightly different and on a good enough hi-fi system a good enough Golden Ear should be able to identify them by their slight differences. The music and record are otherwise interesting only to the guy who wants his Strauss complete. The songs are no great shakes and the soprano is overrecorded in spots with an unhappy effect on a not-too-good voice.

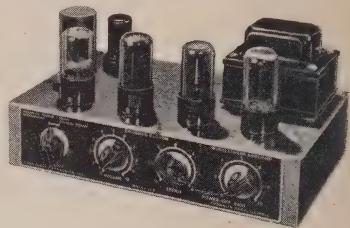
The Three Ravens
Songs of Elizabethan England
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guitar and lute accompaniment
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N-54M	17.10	150	115	115
N-67A	16.30	150	230/115	115
N-55M	30.20	250	115	115
N-66A	25.40	250	230/115	115
N-57M	50.70	500	115	115
N-59M	86.50	1000	115	115
N-52M	38.70	350	95 to 130	115

With switch and meter for primary voltage control.
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might miss something you would enjoy very much. The Deller voice (a male alto) is one of the most remarkable voices you'll ever hear and it is recorded here with great purity, and indeed with enough leeway so that even an only fair system should not spoil its beautiful round tones. The songs are more interesting than you might expect and include such old favorites as Barbara Allen and Greensleeves. There are in addition two delightful lute solos. You can probably get your money back betting your friends that they can't guess whether it's a male or female voice.

MOZART:*Serenade No. 12 (K388)**Divertimento No. 15 (K287)*

Arthur Fiedler and His Sinfonietta

RCA Victor LM-1936

This is a Mozart anniversary and all the companies are putting out new Mozart recordings. This is a particularly pleasant one. The *Serenade* is for double woodwinds and horns and presents a lovely woodwind tone, beautifully recorded with excellent presence. The *Divertimento* is one of a considerable number for strings and horns. This particular one is especially pleasant and shares the excellent recording.

*Divertimento No. 17 (K334)**Eine Kleine Nachtmusik (K525)*

Reiner and Chicago Symphony Orchestra

RCA Victor LM-1966

Another very pleasant *Divertimento* and the ever-popular *Eine Kleine* in a bigger orchestral version, also well recorded and with excellent presence.

Symphonies No. 36, 39, 40 and 41

Reiner and Chicago Symphony

RCA Victor LM-6035
(two 12-inch records)

An anniversary album of the four greatest Mozart symphonies in performances and recordings which do them complete justice. The polyphonic style provides excellent material for testing or demonstrating definition. The strings are loud enough in some places to overtax some pickups.

*Quartet in G Major (K387)**Quartet in D Minor (K421)*

Bachelet Quartet

Vox PL-9480

If you prefer intimate chamber music, this will provide excellent presence. Two of the best of Mozart's quartets with some of his most touching melodies. Excellent recording quality.

Moritat

Dick Hyman Trio

MGM K-12149

This one slipped past me when it first came. If you can find a copy, by all means buy it. One of the best and most engaging demonstration and showoff records I know of. Some really extraordinary piano effects nicely and cleanly recorded, with a good bass and good trap highs.

*IBERT: Les Amours de Jupiter**Escalas*

Composer conducting Orchestra of Paris Opera

Capitol P-18004

Two more examples to prove, if proof is needed, that modernism is neither all dissonance nor all alike. *Escalas* (Ports of Call) is an impressionistic travologue which causes no pain at all. The kettle drums are especially good in the second movement and there are sharp castanets in the third. The amusingly satirical *Jupiter* shares the same outstanding kettle drums, has some fine horns, a complex orchestration which needs good definition and a brilliant sound throughout. The jaded ear should enjoy this thoroughly.

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, 154 West 14th St., New York II, N.Y.

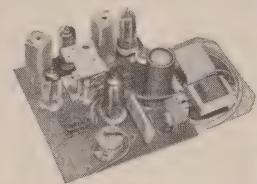
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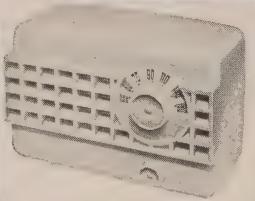


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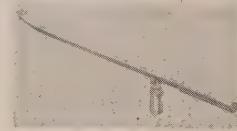
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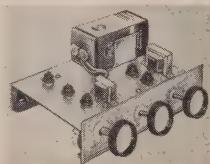
ings are standard ½-inch centered studs, tapped for 3/48 threads. Built-in calibration mark for overhang adjustment. Arm lifts off base for inspection and cleaning. Can be disconnected for safety. ¼-inch hole needed for mounting. Polished aluminum finish.—**Volpar**, 4404 W. 2nd St., Panama City, Fla.

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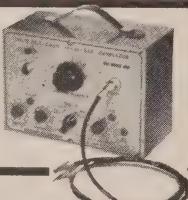
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ANTENNAS. *Zephyr Royal* (see photo) with Wing director. Stagger tuning gives flat frequency response in color reception. Rejector phasing eliminated.—**Davis Electronics**, 4002 W. Burbank Blvd., Burbank, Calif.



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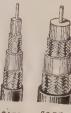


ANTENNAS, models 404 and 505. Cover channels 2 to 83. Telescoping dipoles. Swivel on ball and socket in any direction. Gold spirals, plastic base, gold



uprights.—**Hi-Lo TV Antenna Corp.**, 3540 No. Ravenswood Ave., Chicago, Ill.

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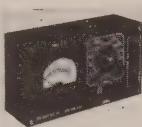
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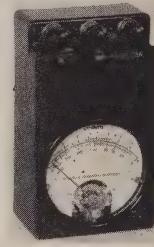


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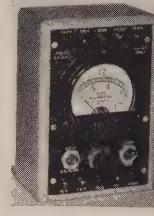


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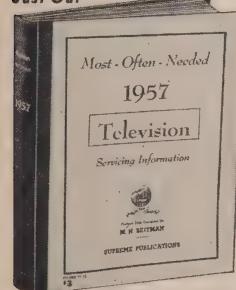
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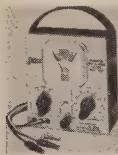
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circuits in one operation. Vacuum-tube voltmeter indicating device. Built-in safeguards against overload and meter burnout. Plastic sleeve protects test rod. Test rods for special coils, 14 x 8 x 8 inches, ½-inch standard test rod.—B&K Mfg. Co., 3731 No. Southport Ave., Chicago 13, Ill.

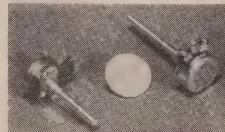
TRANSISTOR CHECKER. Model TDC 22. Tests transistors and crystal diodes without removal from circuit. Gain control varies 6-volt battery voltage for different gain transistors. Setup chart in removable booklet mounted in plastic folder on rear of unit. Checks p-n-p and



n-p-n transistors for current gain, leakage, opens and shorts; crystal diodes for forward-to-backward resistance ratio. Uhf diodes protected by reduced voltage. Clear plastic meter. 2-tone steel demagnetized case.—Service Instruments Co., 171 Official Rd., Addison, Ill.

calibrating. Uses inexpensive flashlight batteries. Punched, lettered and finished panel, 17-page instruction manual.—Kitt-Tronics, 2315 Hendola Dr. N. E., Albuquerque, N. M.

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with 0.5 amp 25-volt dc rating.—Clarostat Mfg. Co., Inc., Dover, N. H.

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aircraft and marine communications and allied electronic equipment. 90% efficiency minimizes heat dissipation. Hermetic seal makes it explosion-proof. Almost total absence of radio and acoustic noises.—Hycon Mfg. Co., 2961 E. Colorado St., Pasadena, Calif.

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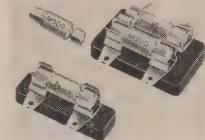
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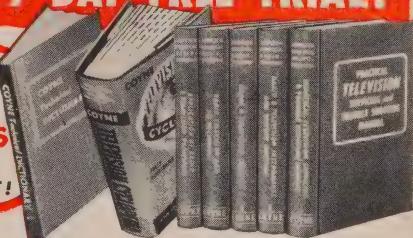
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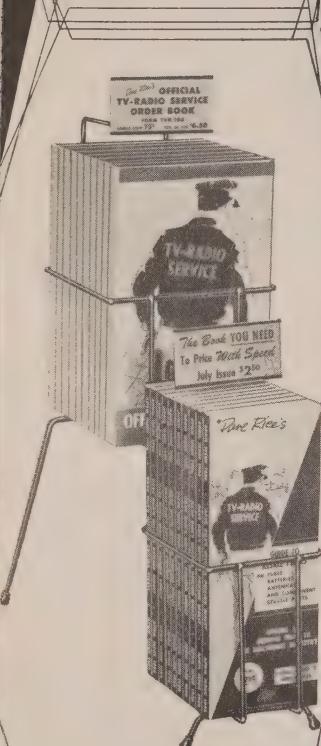
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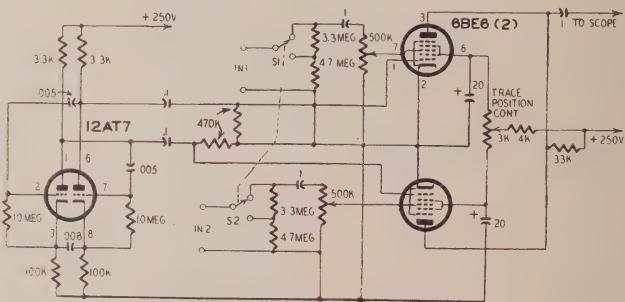


ELECTRONIC SWITCH

When a single-beam oscilloscope is used to compare related waveforms, it is necessary to switch the scope input from one source to the other. This makes it almost impossible to detect minor differences in waveshapes. Waveform studies can be simplified by using an electronic switch to connect the two sources alternately to the scope.

The twin-channel electronic switch shown in the diagram is reprinted from *Radioamater*, a Yugoslavian amateur radio magazine. The 12AT7 is a multi-vibrator type square-wave generator. The square-wave pulses on its plates are 180° out of phase and are fed to

the oscillator grids of the 6BE6 signal amplifiers. Signals from source 1 and source 2 are fed to grid 3 of the 6BE6's through variable attenuators. The square waves on the oscillator grids alternately block and unblock the 6BE6's so the signals applied to the signal grids are alternately amplified and fed to the input of the oscilloscope. The amplitudes of the two input signals are varied simultaneously by the ganged two-step attenuators and separately by the 500,000-ohm potentiometers in the input circuits. The 3,000-ohm control between the 6BE6 screens varies the separation between the two traces.



IMPROVING THE LP-1 DOT-BAR GENERATOR

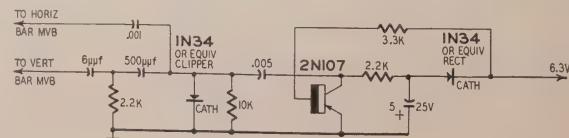
An unstable pattern is particularly annoying when using a dot-bar generator to adjust convergence in a color TV set. This trouble is common to most low-priced units. The Heathkit LP-1—as well as several others—is troublesome because it is very difficult to keep the horizontal bars locked in with the power line. This causes the pattern to jitter at a rate determined by the difference between the power-line frequency and the frequency at which the set's vertical oscillator tends to lock.

Prompted by the article "Transistorized Scope Calibrator" (RADIO-ELECTRONICS, February, 1956) describing a square-wave generator as a voltage-reference source, I developed a prac-

tical circuit for syncing the dot-bar generator to the power-line frequency. Briefly, the 60-cycle line signal is squared, differentiated and then clipped to provide a sync signal for the horizontal-bar multivibrator in the LP-1. The sync circuit is shown in the diagram.

A 6-volt 60-cycle signal is tapped off the power supply and rectified by a 1N34 or similar germanium diode to supply operating voltage for the transistor. A part of the ac signal is fed through the 3,300-ohm resistor to the transistor base. The transistor acts like an on-off switch opened and closed at a 60-cycle rate.

A square-wave signal is taken from



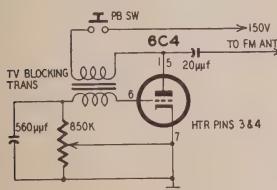
RADIO-ELECTRONIC CIRCUITS (Continued)

the collector and differentiated by the .005- μ f capacitor and 10,000-ohm resistor. A diode clipper shunts this resistor and clips the signal so only the negative-going spike is left. This spike (about 2 volts peak to peak) is tapped off and fed through a .001- μ f capacitor to pin 1 of the horizontal-bar multivibrator to lock it effectively in at any multiple of 60 cycles within the range of its control. Simultaneously the spike is passed through another differentiator (a 500- μ uf capacitor and 2,200-ohm resistor) and fed to the vertical-bar multivibrator to improve its frequency stability.

This circuit is easy to add to the LP-1 and similar equipment. A 7-point terminal strip for mounting the new parts was fastened to the rear skirt of the LP-1 chassis. The .001- μ f capacitor connects between a terminal on the strip and pin 1 on the 6J6 horizontal-bar multivibrator socket. A lead runs from the free end of the 500- μ uf capacitor on the strip to an unused terminal on a strip near the vertical-bar multivibrator. A 2,200-ohm resistor is connected from this point to ground and the 6- μ uf capacitor goes to pin 5 on the vertical-bar multivibrator socket. The 3,300-ohm resistor and rectifier diode connect to one heater pin on the 6X4 rectifier socket.—John A. Wheaton

FM TUNING AID

A simple blocking oscillator using an old two-winding TV blocking transformer makes an excellent tuning aid for FM receivers, especially those using a gated-beam (6BN6) detector where an electron-ray type tuning indicator will not work. The blocking oscillator



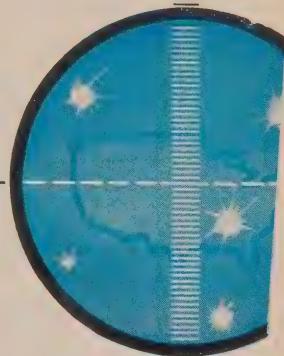
shown in the diagram generates a rather short pulse with a fairly fast rise time throughout the region of the FM band, and the fundamental frequency of the oscillator, since it lies within the audio spectrum, lends an audible tone to the pulse. To tune in a station "on the nose," press the push-button and tune the receiver in the usual manner to a noise null. Power requirements of the oscillator are comparatively small and in most cases may be obtained directly from the receiver power supply. The output of the oscillator is loosely coupled to the FM antenna input by wrapping a few turns of wire around the lead-in.

Where an appreciable amount of FM servicing is done this unit can be built into a small box using a selenium rectifier supply and small heater transformer.—Warren J. Smith END

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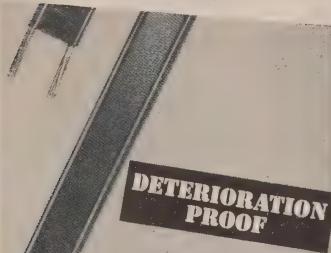
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Technicians' News



NATESA CONVENES

Most important action of the convention of the National Alliance of TV & Electronic Service Associations at its annual convention in September was a declaration of war on "captive service."

To avoid any confusion as to the meaning of the term, captive service was defined as "Services offered to consumers on a fee or no-charge basis by a TV or radio receiver manufacturer, their subsidiaries, agents or segment of a receiver distribution other than the retail merchandiser." No definite plans or campaign tactics were made public, but it was understood that this as well as other "growing industry problems" was one of the causes for the streamlining of the organization that was voted. A 12-man executive council was elected to replace the previous 56-member board of directors, which was too widely scattered and unwieldy for the most effective action.

First act of the new executive council was the appointment of Mr. Frank Moch as executive director. Mr. Moch will devote the larger part of his time to this new post, handling his TV-radio service business largely through subordinates. Mr. Moch's appointment is for a period of two years, with a salary of \$12,500 per year, plus expenses. He will be a member of the executive board.

Albert C. W. Saunders of the Saunders School of Television (Boston, Mass.) was reappointed educational director of the organization.

Robert Hester of Kansas City was elected president of the Alliance for the forthcoming year, after a spirited campaign at which the runner-up was Vincent Lutz of St. Louis. F. B. Koepnick of Houston was elected secretary general; C. Nelson Burns of Memphis, treasurer. Regional vice presidents are Robert Kidd, Norfolk, Eastern; Russ Harmon, Cincinnati, East Central; H. O. Eales, Oklahoma City, West Central; Winston Haines, Burlingame, (Calif.). Western. Secretaries are Pascal P. Pratt, Buffalo, Eastern; Joe Driscoll, St. Paul, West Central; Harold Stein, Denver, Western.

A new comprehensive insurance plan was adopted. Essentially a group insurance and indemnity plan, it will protect members and their employees when the need for payment of hospital and surgical expenses arises. The plan also provides for such future protection as retirement income and life insur-

ance. It was specifically tailored for NATESA by insurance consultants in Cincinnati.

Friends of Service Management awards were voted on a continuing basis to Howard Sams, P. R. Mallory, Sylvania Electric Products, Sprague Products and *Technician Magazine*. First-time winners were *Service Dealer* magazine and the CBS tube division. Due to "the present unsettled conditions" regarding service business, no award was voted in the TV set manufacturing division, according to the executive council of the service organization.

T.E.A. CONVENES

The Texas Electronics Association held its fourth annual clinic and fair Aug. 24, 25 and 26. Over 500 service technicians attended the sessions, which were held in the Rice Hotel at Houston. The interest shown was indicated by the fact that some of the sessions commenced at 8 am (after a 7:10 am breakfast) with a coffee break from 9 to 9:45, after which the session reopened till 11:15. Subjects discussed ranged from color and hi-fi through transistors and modules to automation. Some of the best speakers ever to appear before a state service technicians' convention addressed the meetings. Among them were Dr. Allen B. Du Mont, John Rider, Dorman Israel of Emerson, James Lansing of James Lansing Sound and W. L. Parkinson of General Electric. It was at this meeting that Parkinson announced General Electric's plans to go into the TV service field. Past President Forrest Baker also reported on the newly formed American Electronics Council.

The program was so arranged that exhibits and lectures did not find themselves in competition, as has unfortunately been the case in some service conferences. In addition, a special program offered the ladies interesting activities for part of each of the three days of the convention.

AEC APPOINTS SECRETARY

The American Electronic Council has set up its national office at 822 Central Building, Wichita, Kans., reports its president, Forrest Baker.

C. D. (Jack) Hughes was appointed executive secretary. Mr. Hughes has served as executive secretary for the Wichita Appliance Dealers Association and the Kansas Appliance Dealers Association for the past four years, is the author of the recently published

9

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TECHNICIANS' NEWS (Continued)
book *How to Organize and Operate a Small Association* and has been active in the promotion of the National Appliance, Radio & TV Dealers Association.

G-E's SERVICE PLAN

Further information on the General Electric factory service scheme was revealed by Wm. L. Parkinson of the G-E appliance and TV receiver division, in an interview about two weeks after the initial announcement at the Houston convention of the Texas Electronic Association.

Mr. Parkinson, as reported by *Television Digest*, believed that G-E would be able to start factory servicing in three test cities by Nov. 1. "Ideally," he stated, "we would then like to wait about six months before entering other markets. However . . . we are getting cross-pressure. Independent servicemen are trying to get us to hold off; our own independent distributors are urging us to move quickly in their markets."

Parkinson also pointed out that G-E intended to franchise independent service organizations as factory service stations wherever advisable. "I did not mention that in my Texas speech," he stated, "so it hasn't been reported, but just because we're setting up factory service branches in some markets doesn't mean we're sending out a crew from the factory. Where we can find a strong independent, we'll franchise him as our branch. . . . We don't want to replace any independent serviceman or take any business away from him. We're out to lend stability to the service business, to cut down on complaints we've been getting about servicing—and believe me, they are enormous! Frankly, we have a great deal of respect for the competence of the average serviceman—but we also must face the fact that a very high percentage of them are unqualified. They, and only they, figure to be hurt by our program."

NEW SERVICE PAPER

We have received Vol. 1, No. 1 of *The Raster*, a publication of the Electronic Service Council of the Ozarks. ESCO is composed of three organizations in southern Missouri, TESA of Southwest Missouri, TESA of the Ozarks and TESA—South Central Missouri. *The Raster* will be published monthly and sent to all electronic technicians in southern Missouri.

The 10-page paper is larger than the usual run of service publications and is printed on excellent glossy stock. Contents include editorial matter and local advertising. A technical article (on a slave substitution unit) appears as well as a number of short kinks. The news includes the TESA-MO state meeting and a new association in southeast Missouri, a column of personals and two letters to the editor. The new paper seems to be off to a good start and well on the way to becoming a strong influence in four states.

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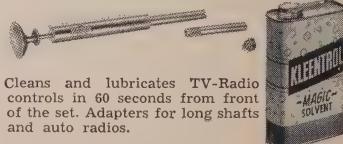
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Tubes Transistors



Returning to normalcy after several months of heavy output in new tube and transistor releases, this month's announcements include a new beam power tube, an interesting plug-in selenium rectifier, a damper for series heater strings, an audio output transistor for auto radios and an ingenious Wamoscope.

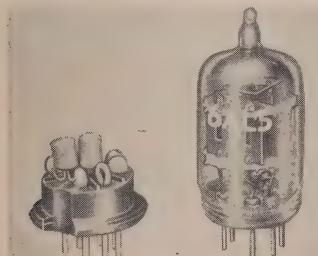
6DG6

A beam power tube of the glass octal type, the 6DG6, announced by RCA, is designed primarily for use as an output tube in audio amplifiers. The tube has a 6.3-volt 1.2-ampere heater and a maximum peak heater-cathode voltage of ± 90 volts, but otherwise is like the 25L6-GT. It has high power sensitivity and high efficiency at relatively low plate and grid-2 voltages.

In typical operation as a class-A amplifier, plate voltage is 200; grid-2 voltage, 125; cathode resistor, 180 ohms; peak af grid-1 voltage, 8.5; zero-signal plate current, 46 ma; maximum-signal plate current, 47 ma; zero-signal grid-2 current, 2.2 ma; maximum-signal grid-2 current, 8.5 ma; plate resistance (approximately), 28,000 ohms; transconductance, 8,000 μ mhos; load resistance, 4,000 ohms; total harmonic distortion, 10%; maximum-signal power output, 3.8 watts. Maximum plate dissipation is 10 watts; maximum grid-2 input is 1.25 watts.

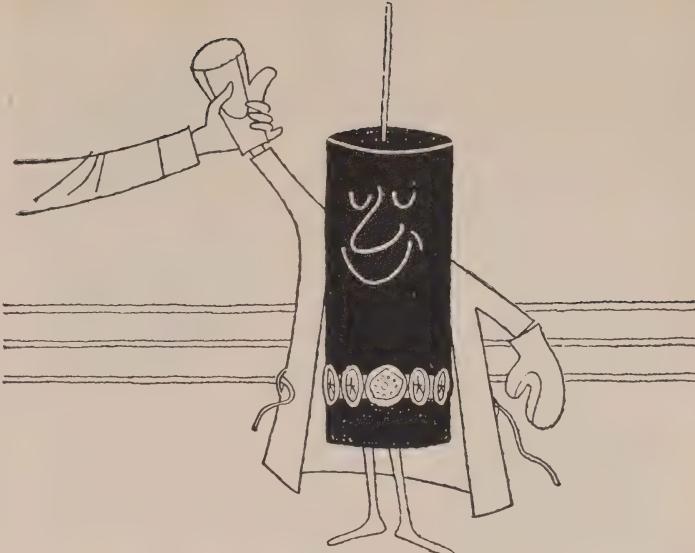
Selenium plug-in diode

A small, compact plug-in selenium rectifier, the 60-7788 has been especially designed by International Rectifier Corp. to replace the 6AL5 tube in many TV sync discriminator circuits. These subminiature units offer advantages



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This unit (see photo) consists of two



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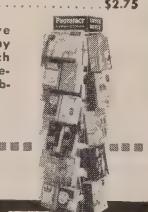
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International 1U1 selenium diodes, mounted and soldered to a plug that fits a seven-pin miniature tube socket. Each diode is designed to deliver 20 volts dc at 1.5 ma for an rms voltage input of 26 maximum and may be operated through an ambient temperature range of -50°C to 100°C. The diodes are completely encapsulated within a thermosetting plastic to protect them from moisture, corrosive atmosphere and fungi.

In addition to their application as horizontal sync phase discriminators in television receivers, these diodes are ideal components for bias supplies, power supplies for sensitive relays, in computers and in many other circuits.

19AU4

Another RCA announcement is the 19AU4, a half-wave vacuum rectifier tube of the glass octal type. It is particularly suited for use as a damper diode in the horizontal deflection circuits of black-and-white television receivers using series heater strings.

Rated to withstand a maximum peak inverse plate voltage of 4,500, the 19AU4 can supply a maximum peak plate current of 1,050 ma and a maximum de plate current of 175 ma. Designed with insulation between heater and cathode to withstand negative peak pulses between them of as much as 4,500 volts with a dc component up to 900 volts, the 19AU4 permits flexibility in choice of deflection circuits.

The heater requirements of the 19AU4 are 18.9 volts and 600 ma. Maximum seated length is 3½ inches and base connections are the same as the 6AU4GT. Maximum plate dissipation is 6 watts.

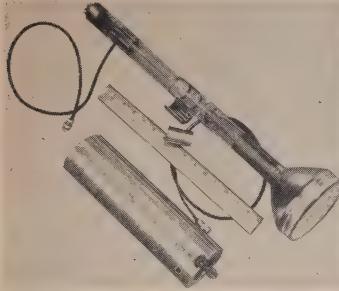
2N242

A hermetically sealed power transistor for automobile radios has been announced by Sylvania. Designated as type 2N242, the unit is a p-n-p alloy junction germanium transistor designed for the audio output stage and other applications. In mounting, the collector is grounded to the chassis.

Maximum ratings for the 2N242 at 25°C are: collector-to-base voltage, -45; collector-to-emitter voltage, -45; collector current, steady state, -2 amps. Operating at 12 volts, the 2N242 provides 2.5 watts of class-A output with less than 5% harmonic distortion.

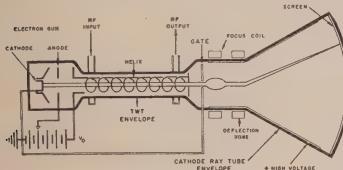
6762 Wamoscope

A radically new type of cathode-ray tube for radar, microwave television and other electronic display applications has been announced by Sylvania. Developed in cooperation with the Naval Research Laboratory, the 6762, dubbed the Wamoscope (wave-modulated oscilloscope), combines the essential functions of a microwave receiving set in a single tube envelope, eliminating many of the tubes and components



required by conventional microwave receivers. (See photo and drawing.)

Microwave signals go directly from the antenna into the tube, where they are amplified, detected and displayed on the tube's fluorescent screen. The 6762 is about 20 inches long and has a 5-inch diameter screen. The solenoid



shown fits over the traveling-wave tube section to focus it and over the tube's rf transducers. Operation is in the frequency range of 2000-4000 mc. END

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Modern Electric	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

In November, 1922, Science and Invention (formerly Electrical Experimenter)

World-Time Clock for Radio Stations, by Dr. Alfred Gradenwitz.
The Smallest Radio Outfit Contest, by E. S. Gunn, Sixth Prize Winner.
Glass Bottle Regenerative Receiver, by T. H. Halstead.
Radio Aerial Pole, by Henry Frey.
Practical Data on Radio-Frequency Amplification, by Robert E. Lacaut.



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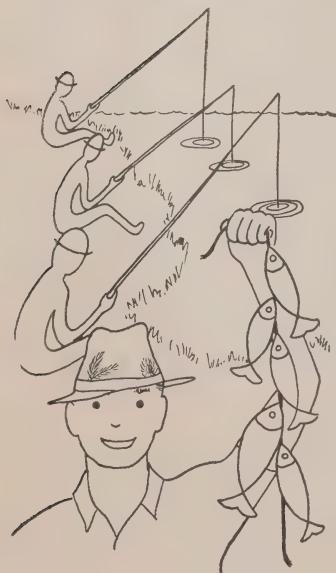
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Question Box



5-STATION INTERCOM SET

Kindly publish a diagram of a master intercom unit with four remote stations. The remote stations should be able to call the master but not each other. Please show a switching arrangement which will permit the master to make simultaneous announcements to all of the remote stations.—C. T., Denton, Md.

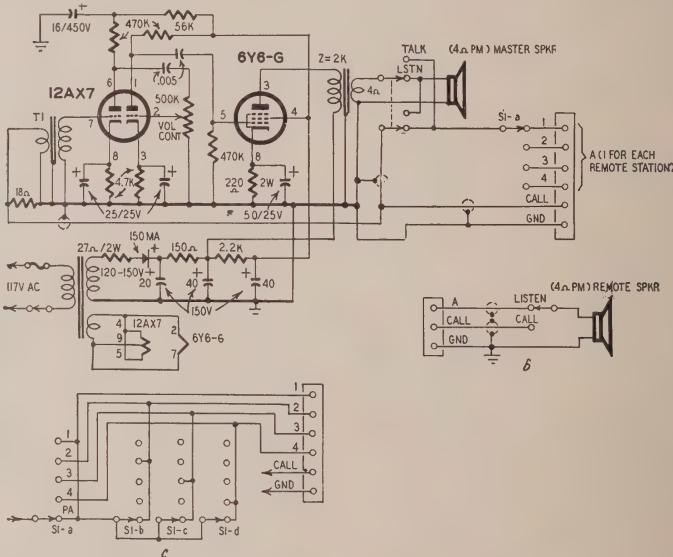
The diagram at *a* is the schematic of a suitable master amplifier for an intercom system. You can substitute almost any equivalent audio amplifier circuit. Naturally, the output transformer should match the power amplifier tube(s) to the 4-ohm speaker. T1 may be a special intercom input trans-

spring-return type dpdt lever switch wired so it is normally in the LISTEN position. Single-pole double-throw lever switches are used on each remote. These switches are spring-return types wired so they return to the LISTEN position.

To use the master as a PA unit to call all stations, the selector switch must have one more position than there are remote stations. In addition, it should have the same number of circuits (decks or wafers) as there are remotes.

The drawing at *c* shows the wiring of the selector switch with the PA position added. S1-a is the same in diagrams *a* and *c*.

The necessity for shielding depends on the gain of the amplifier and on the layout of parts. It may be necessary to



former designed to match a voice coil to a grid or it may be a small output transformer with its primary connected to the grid of the input stage.

The diagram at *b* shows the wiring of each of the remote stations. The master is designed for four remotes. You can use as many as you want as long as the selector switch S1-a has one position for each remote. The TALK-LISTEN switch on the master is a

SPEAKER BAFFLE LINERS

I'm constructing a speaker enclosure. The instructions recommend lining the inside with Kimsul, Ozite or Fiberglas

use shielded leads in the CALL and LISTEN circuits, but it is not advisable to install shielded cables until tests show it to be necessary.

Speakers with voice coils of around 4 ohms are satisfactory for many installations, but we recommend 45-ohm types with matching input and output transformers if the average distance from the master to remote is more than 75 feet or so. This minimizes power loss.

batts. Please describe these materials and tell me where they can be purchased.—N. J. S., Blowing Rock, N.C.

Ozite is the trade name of a material used as cushioning for rugs and carpets. It is generally available at rug and carpet dealers.

Fiberglas bats are widely used for insulating hot-cold food containers, hot-air heating ducts, as weatherstripping and for inserting under automobile hoods to minimize engine noise. It is easily glued, stapled or tacked to most surfaces and is readily available in thicknesses of 1 and 2 inches. You can get it at hardware stores, building supply houses and auto accessory stores. Mail-order houses such as Sears Roebuck sell rolls of 1-inch thick Fiberglas insulation 3 feet wide and 8 feet long for less than \$2.

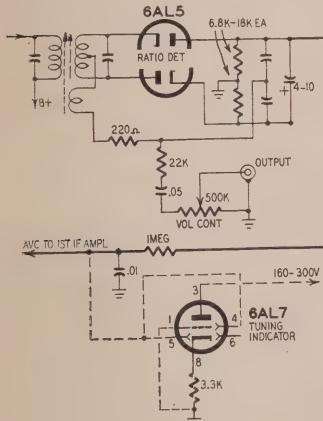
Kimsul is an insulation widely used in the building trades. It consists of a 1-, 1½- or 2-inch-thick blanket of many thin layers of cellulose fiber stitched to a soft fiberboard binder. It comes in rolls 16 and 24 inches wide, containing 100 and 200 square feet. Cost is less than 10 cents per square foot at most building supply houses.

Ozite and Fiberglas bats are preferable because they can be obtained in smaller quantities.

FM TUNING INDICATOR

I have a Meissner model 8C FM tuner. Please show how a tuning indicator can be added to it.—R. P., Mountain Lakes, N. J.

The diagram shows how a 6AL7 tuning indicator can be connected to the tuner. The ave system (shown in heavy lines) is used as a source of control voltage for the tuning indicator.



Automatic volume control is not used in all 8C tuners. If yours lacks this feature, you can add it at the same time that the indicator is being installed. Simply lift the first if amplifier grid return from ground and connect it to the ave line. The dashed lines show the connections for the tuning indicator.

The Question Box of the February, 1956, issue describes two vtv type circuits with neon lamps used as indicators.

END

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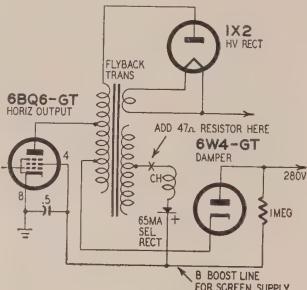
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SETCHELL CARLSON 151

Double trouble developed in the novel screen supply to this receiver. The circuit (see diagram) uses a selenium rectifier in a simple B-boost circuit to increase the voltage to the screen of the horizontal output tube.



A vertical dark space, that could be varied both in width and darkness by the drive control, was the first symptom that developed. It occupied the middle third of the screen and had the appearance of a vertical hum bar, with smaller vertical bars within it.

Measurements indicated the high voltage and the output tube screen voltage were low. Replacing the horizontal oscillator and output tubes did not help. Finally, bridging the screen bypass capacitor with a similar unit increased screen brightness and provided normal performance.

A month later I had a callback with a complaint of insufficient brightness. Again the output tube screen voltage measured low; replacing the selenium rectifier cured the trouble. A month later the trouble recurred and again the rectifier was defective. This time terminal 5 of the flyback was opened and a 47-ohm 2-watt resistor inserted to limit surge current through the rectifier. The choke apparently did not do too good a job of surge limiting since it was supplanted by a resistor in later models.—Alfred Roberts

ZENITH 5L42 RADIO

After the second set of tubes went bad within a few days, the customer was understandably irate. The trouble was due to a partially shorted .001- μ F capacitor acting as a tone compensator in the plate circuit of the audio output tube, a 3V4. The leak permitted B plus to flow through the output transformer to this capacitor, through it to the A-plus side of the series tube filament string and thence to A minus, mostly



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by way of the tube filaments, overheating these tubes. Such filament type tubes are very sensitive to overvoltage and only a small amount of excess voltage will do them in very quickly. Not enough of a short was present in the capacitor to kill the sound, but enough leakage was present to kill the tubes!—Eugene Rollins

WIDTH INCREASE

Increased capacitance from the plate of the horizontal output tube to the chassis or B minus will increase the width of the raster.

The maximum that may be obtained by this method is about 2 inches on a 21-inch tube—often sufficient. The more added capacitance, the more the width, running about $\frac{1}{4}$ inch for 10 μuf with a maximum of 25 μuf . More than this value will lower the high voltage, and the integrating action will prolong the retrace period (horizontal) so that it may not occur within the blanking time.

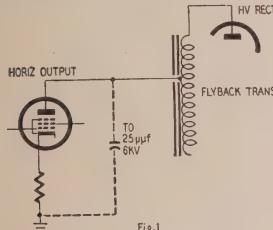


Fig. 1

Fig. 1 shows the idea. The capacitor is connected from the cap of the output tube to chassis or B minus (to which ever the cathode resistor returns). The capacitor must have a rating of at least 5 kv and preferably more. It may be connected across the lower half of the flyback in some cases, making it unnecessary to remove the chassis.



Fig. 2

Fig. 2 shows how the width may be stretched about $\frac{1}{2}$ inch. A piece of insulated wire is taped (with Scotch tape) to the high-voltage wire (plate lead) running to the cap of the horizontal output tube. The free end of the wire goes to chassis or B minus as before. The insulation forms the dielectric of the capacitor. Or the wire may be coiled around the lead to the tube cap.—James A. McRoberts

PORTABLE RADIOS

The line plugs used on some RCA and other three-way portables are polarized so one side of the line cord completes a circuit to one side of the on-off switch when the set is used on batteries.

If the set does not work on batteries, check the line plug. I have found several instances where the original plugs have been replaced or reconnected incorrectly.—J. V. Cavasenno



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COMPLETE INDEX PAGE 170

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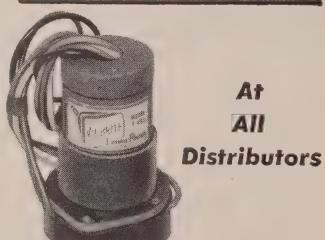
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Patents



ANIMATED ELECTRIC TOY

Patent No. 2,752,730

George R. Bellett, Venice, and Donald C. Porter, Bakersfield, Calif. (Assigned to Donald C. Porter, Arcadia, Calif.)

Powered by a voltaic cell using the acid of a lemon, grapefruit or apple, this animated toy can wag its tail, wiggle ears, etc. Fig. 1 shows a toy dog designed to hold a lemon "power supply." Its tail wags until the fruit acid is used up, possibly several days.

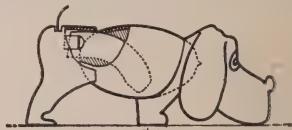


Fig.1

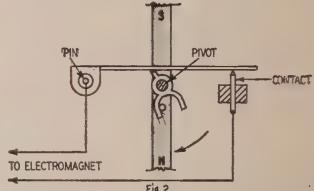


Fig.2

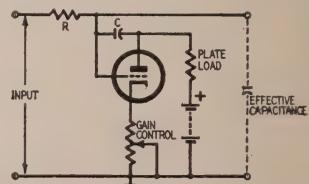
The lemon is slit so that blotting paper draws up the acid. The paper is placed between zinc and copper electrodes to form an electrical cell sufficiently powerful to energize an electromagnet. Also, a flat bar magnet (Fig. 2) is camouflaged and decorated to make its upper end look like a tail. When the electromagnet is de-energized, the bar magnet remains vertical, as shown. When voltage is applied from the acid cell, the N pole is repelled to the left, as shown by the arrow. This lifts a silver leaf spring to break a contact and interrupt current to the electromagnet. Therefore the magnet swings back and the contact is remade.

TIME-CONSTANT AMPLIFIER

Patent No. 2,743,358

Neil E. Handel, Wrentham, Mass. (Assigned to Foxboro Co., Foxboro, Mass.)

The time constant of an R-C network (its product in ohms and farads) equals the time (in seconds) required for the network to charge to 63% of its final value. A large time constant, say 10 minutes, is difficult to attain because of the very large capacitor and resistor that must be used. However, it is easily accomplished by the Miller effect.



When a tube operates as an amplifier its effective input capacitance is greater than its actual capacitance when the tube is cold. The increase varies with gain. Approximately, the effective capacitance equals the gain multiplied

PATENTS

by the plate-grid capacitance. This is the Miller effect.

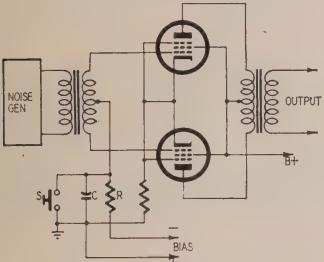
A recommended circuit is shown. If C is 12 μ F and stage gain is 30, the effective input capacitance (dashed lines) will equal 360 μ F. If R is 1 megohm, the time constant is 1 hour (3,600 seconds).

SOUND EFFECTS DEVICE

Patent No. 2,751,585

Jarrett L. Hathaway, Manhasset, N. Y.; Raymond E. Lafferty, Fairlawn, N. J. (Assigned to RCA)

Noises like thunder, gunshots and the crashing of waves contain a confused mixture of frequencies over a wide band. Except for their duration and rate of decay, there is not too much difference between them. This device utilizes a noise generator to simulate many sounds. The noise is gated (as to duration and decay) to produce required sounds.



The figure shows an amplifier normally blocked by a negative bias supply. When the pushbutton switch S is depressed, the grids are grounded through the transformer center tap. The amplifier now transmits the noise signal. When S is released, the bias supply charges C through R. The noise gradually dies out. Eventually the capacitor charge blocks the tubes completely.

(Continued)

This amplifier may be controlled to produce realistic gunshot sounds, for example. Blank cartridges are not reliable for this purpose because their sound output is not uniform. Here the sound of the blank cartridge is picked up and amplified. It triggers an electronic switch (instead of S). A realistic gun noise requires closure of the switch circuit for about 10 milliseconds. The decay time (controlled by R and C) should be about $\frac{1}{4}$ second, after which the amplifier should block again.

TRANS-ATLANTIC RADIO RELAY

Patent No. 2,748,266

Richard C. Boyd, Summit, N. J. (Assigned to Bell Telephone Labs., Inc.)

This calls for hourly flights of Stratocruisers flying at 11,000 feet. They would carry a pay load of up to 5 tons in addition to the necessary microwave relay equipment. Flying at intervals of 200 miles along the route between New York and London, they could relay TV and telephone signals on a carrier of approximately 6000 mc.

Each plane would receive signals on one frequency and transmit them on another (both near 6000 mc) to eliminate possibility of interference. However, the first and last plane in each relay line would utilize one of two special "shore" frequencies when within 200 miles from shore. This is done to prevent the need for each terminal station to change frequency every hour as a plane enters or leaves the relay line.

Should any plane develop trouble that requires it to leave the line, it would signal the planes ahead and behind it. These planes would immediately change speed so as to maintain a distance of 267 miles, rather than 200 miles. This closes the gap, with four planes covering the distance normally requiring five planes. This would create a problem of frequency, with two planes sending and receiving on the same single frequency. To avoid this, the planes filling the gap would switch to one of the "shore" frequencies to link them. END

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753/16, 755/16, 757/16, 759/16, 761/16, 763/16, 765/16, 767/16, 769/16, 771/16, 773/16, 775/16, 777/16, 779/16, 781/16, 783/16, 785/16, 787/16, 789/16, 791/16, 793/16, 795/16, 797/16, 799/16, 801/16, 803/16, 805/16, 807/16, 809/16, 811/16, 813/16, 815/16, 817/16, 819/16, 821/16, 823/16, 825/16, 827/16, 829/16, 831/16, 833/16, 835/16, 837/16, 839/16, 841/16, 843/16, 845/16, 847/16, 849/16, 851/16, 853/16, 855/16, 857/16, 859/16, 861/16, 863/16, 865/16, 867/16, 869/16, 871/16, 873/16, 875/16, 877/16, 879/16, 881/16, 883/16, 885/16, 887/16, 889/16, 891/16, 893/16, 895/16, 897/16, 899/16, 901/16, 903/16, 905/16, 907/16, 909/16, 911/16, 913/16, 915/16, 917/16, 919/16, 921/16, 923/16, 925/16, 927/16, 929/16, 931/16, 933/16, 935/16, 937/16, 939/16, 941/16, 943/16, 945/16, 947/16, 949/16, 951/16, 953/16, 955/16, 957/16, 959/16, 961/16, 963/16, 965/16, 967/16, 969/16, 971/16, 973/16, 975/16, 977/16, 979/16, 981/16, 983/16, 985/16, 987/16, 989/16, 991/16, 993/16, 995/16, 997/16, 999/16, 1001/16, 1003/16, 1005/16, 1007/16, 1009/16, 1011/16, 1013/16, 1015/16, 1017/16, 1019/16, 1021/16, 1023/16, 1025/16, 1027/16, 1029/16, 1031/16, 1033/16, 1035/16, 1037/16, 1039/16, 1041/16, 1043/16, 1045/16, 1047/16, 1049/16, 1051/16, 1053/16, 1055/16, 1057/16, 1059/16, 1061/16, 1063/16, 1065/16, 1067/16, 1069/16, 1071/16, 1073/16, 1075/16, 1077/16, 1079/16, 1081/16, 1083/16, 1085/16, 1087/16, 1089/16, 1091/16, 1093/16, 1095/16, 1097/16, 1099/16, 1101/16, 1103/16, 1105/16, 1107/16, 1109/16, 1111/16, 1113/16, 1115/16, 1117/16, 1119/16, 1121/16, 1123/16, 1125/16, 1127/16, 1129/16, 1131/16, 1133/16, 1135/16, 1137/16, 1139/16, 1141/16, 1143/16, 1145/16, 1147/16, 1149/16, 1151/16, 1153/16, 1155/16, 1157/16, 1159/16, 1161/16, 1163/16, 1165/16, 1167/16, 1169/16, 1171/16, 1173/16, 1175/16, 1177/16, 1179/16, 1181/16, 1183/16, 1185/16, 1187/16, 1189/16, 1191/16, 1193/16, 1195/16, 1197/16, 1199/16, 1201/16, 1203/16, 1205/16, 1207/16, 1209/16, 1211/16, 1213/16, 1215/16, 1217/16, 1219/16, 1221/16, 1223/16, 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RADIO-ELECTRONICS

Thread this loop into the recorder so that it can run continuously without obstruction. Switch to MICROPHONE-RECORD, turn recording gain about half open and thump the microphone once with your finger. Stop the recorder immediately so that this thump will not be erased when the loop begins to repeat its run.

Now set the recorder in playback position. Synchronize a stop watch or the second hand of your wrist watch with the first thump and count the total number occurring within a 120-second interval. This count, divided by a factor X (shown in table) gives the actual operating speed of your recorder.

Actual speed = Thumps in 120 sec
X

X	Rated speed of recorder (ips)
1.6	15
3.2	7.5
6.4	3.75
12.8	1.875

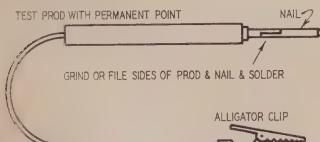
If the recorder is running true, you should count 24 thumps. Assuming a rated speed of 7.5 ips, a count of 23 would indicate an actual speed of 7.19 ips. A count of 25 would indicate 7.81 ips. Both these figures represent an approximate 5% deviation from the ideal—which means that musical pitch is raised or lowered by less than a half tone. To many people this is hardly detectable, if reproduction is from a prerecorded tape. However a critical listener might be disturbed by this slight change of pitch and tempo. If your recorder deviates as much as 2 counts per 120 seconds, this represents an approximate 10% error, which is serious.

If a timing loop isn't long enough to clear all obstructions on the recorder, it may be made twice the ordinary length (but do not double the extra $\frac{1}{4}$ inch added for splicing). In this case divide the factor X by 2 for determining actual speed.—Norman V. Becker

(If you are interested only in measuring 15- and $7\frac{1}{2}$ -ips tapes, the tape may be made 60 inches long. Then a 15-ips tape will give 30 thumps and a $7\frac{1}{2}$ -inch one 15 thumps each 120-second period. X then is equal to 2 in each case.—Editor)

HIGH-VOLTAGE DISCHARGER

An efficient device for discharging the stored-up potential from the high-voltage section of a television set can be made from an old test prod, a nail and an alligator clip.



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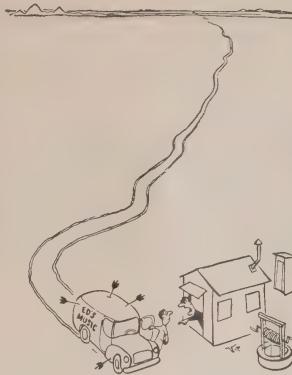
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(Continued)

nail (with head removed, of course). If the tip is not removable, simply solder a nail to it. See drawing. An alligator clip is attached to the other end to complete the device.



The discharger is simple to use. First, fasten the alligator clip to any point on the TV chassis as in the photo. Then, with the test prod, ground the high-voltage lead at the point where it fastens to the picture tube. The length of nail may be pushed under the rubber cup (if present), thus contacting the picture-tube button. If the set uses a voltage-doubler circuit, discharge both capacitors as an added precaution.

—Carleton A. Phillips

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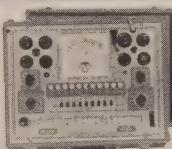
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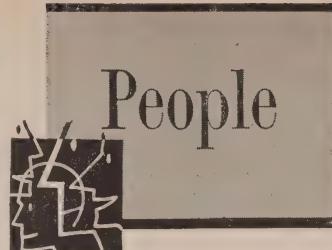
Test Data on New Tube Types
for All Jackson Testers Appears
Monthly on Page 65 of PF Reporter

For This Information Write

JACKSON
ELECTRICAL INSTRUMENT CO.

"Service Engineered" Test Equipment

16-18 S. PATTERSON BLVD., DAYTON 2, OHIO
In Canada: The Canadian Marconi Company



Wilfred L. Larson (top left photo), Switchcraft, was elected president of the newly renamed Electronic Industry Show Corp. at its annual meeting in the Virgin Islands. Jerome Kirshbaum (top right), Precision Apparatus Co., was elected vice president; William J. Moreland (bottom left), Conrac, Inc., was



elected secretary and J. A. Milling (bottom right), Howard W. Sams & Co., Inc., treasurer. The corporation, formerly known as Radio Parts and Electronic Equipment Shows, Inc., manages the annual Electronic Parts Distributors Show in Chicago in May.



Norman L. Harvey, chief engineer of the Sylvania Radio & TV Division, was appointed operations manager-tubes for the tube activities of Sylvania's Electronics Division at Woburn, Mass.

Herman J. Schorle joined Pyramid Electric Co., North Bergen, N. J., as director of manufacturing. He comes to the company from Miamold Electronics Manufacturing Corp.



and radio tools, dies and other equipment, from Admiral Corp. Mattes, a pioneer in the manufacture of consumer radio, was a co-founder of Belmont



Harold C. Mattes was elected vice president in charge of the Private Label Division of Hallicrafters, Chicago, following the purchase of the Raytheon Co., TV

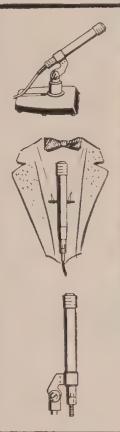
NEW \$70.00

SHURE SLENDYNE

OMNIDIRECTIONAL DYNAMIC PROBE MICROPHONE

IS 5 Microphones IN 1

Model "535"
List Price
\$70.00



**For Public Address
Remote Broadcast
Theater-Stage
Sound Systems**

A completely versatile probe microphone of excellent frequency range (60-13,500) that combines ruggedness, beauty and reliability.

Versatility: Can be used (1) on a floor stand; (2) on a desk stand; (3) quickly removed for use as a hand-held microphone; (4) furnished with lavaliere cord for wearing around the neck; (5) impedance switch permits use as high or low impedance microphone. Accessory on-off switch requires no wiring.

Ruggedness: Built to withstand hard usage and extremes of temperature and humidity.

Beauty: Slender, convenient shape, finished in brushed satin chrome.

Reliability: High efficiency magnetic materials and circuits assure years of consistent high quality performance. Shure quality control techniques result in an exceptionally high degree of uniformity for microphone interchangeability and multiple use.

SLENDYNE Model "530"

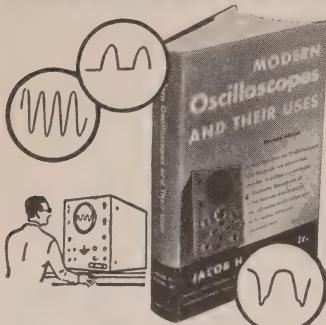
This deluxe version of the Slendyne has a frequency range of 50-15,000 cps and is furnished with a Cannon XL-3-11 broadcast connector. Strikingly attractive non-reflecting black and gold anodized finish.
LIST PRICE \$110.00

The Mark of Quality
SHURE SHURE BROTHERS, INC.

222 HARTREY AVENUE • EVANSTON, ILLINOIS

**HERE'S EVERYTHING
YOU NEED TO
KNOW ABOUT**

OSCILLOSCOPES!



Service any Radio-TV ever built
EASIER - BETTER - FASTER

Oscilloscopes are gold mines for servicemen who learn to use them fast and accurately—and here, in a completely revised 2nd edition, is THE book that really shows you how.

In plain, easily understood language, MODERN OSCILLOSCOPES AND THEIR USES teaches you just when, where and exactly how to use your oscilloscope. You learn how to handle tough jobs easier and faster than you may have dreamed. Every detail is clearly explained—from making connections to adjusting circuit components and setting oscilloscope controls.

Equally important, you learn to analyze patterns accurately in far less time. Almost 400 illustrations including dozens of pattern photos make things doubly clear.

'SCOPES ARE "GOLD MINES"

when you learn to use them fully!

This big book is more widely used than any other of its type—because it gets right down to "brass tacks." No involved mathematics. No complicated discussions. You learn exactly what the oscilloscope is and exactly how to use it on all types of AM, FM and television service (including color)—from locating troubles in a jiffy to handling tough professional jobs.

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232 Madison Ave., New York 16, N. Y.

Send new 2nd edition of 370-page MODERN OSCILLOSCOPES AND THEIR USES for 10-day FREE EXAMINATION. Book is what I want. I will then send you \$7.00 promptly in full payment. If not, I will return book postpaid in good condition and owe you nothing.

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OUTSIDE U.S.A.—Price \$7.00, cash only.
Money back if you return book in 10 days.

PEOPLE

Radio Corp. in 1928 and served as its first president. He became vice president and then president of the Raytheon Radio & TV Division when it absorbed Belmont. L. C. Obrien, Allen Henry, Richard Marholz and Melvin Moore, also former Raytheon executives, join Mattes in the move to Hallcrafters.



Neal W. Turner, chief audio engineer of the Heath Co., Benton Harbor, Mich., was promoted to merchandising manager. He will handle merchandising for the complete Heathkit line of electronic kits for home and industry.



William G. Tuscani will head sales of the newly created Semiconductor Section of Centralab, a division of Globe-Union, Milwaukee, Wis. Earl Clemick, who has been with the company for the last four years, succeeds him as head of packaged electronic circuits sales.



Thomas O. Moore joined the ORR Radio Industries, Opelika, Ala., as chief electronic engineer after a tour of duty in Washington, D.C. working on the Navy's new atomic submarines.



Obituary

Col. Herbert H. Frost, a pioneer in the radio equipment manufacturing industry, recently, in Washington, D. C., after a long illness. Colonel Frost was first president of RMA (now RETMA). Colonel Frost was probably best known to experimenters for the famous Frost phones and to the trade as West Coast manager of E. T. Cunningham, whose tubes were one of the two standard brands of the Twenties.

Personnel Notes

Peter Weil was promoted to assistant manager of the Technical Products Division of Allen B. Du Mont Labs., Clifton, N. J. He had been assistant to the division manager.

Correction

The name of Mike Remund, recently appointed vice president in charge of sales of Jensen Industries, Forest Park, Ill., was incorrectly spelled "Redmund" in October's RADIO ELECTRONICS. END

(Continued)

still **TOPS...**
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2-Set market!

the

MOSLEY Dual-Match TV Coupler

tops for...

- 1 Impedance match
- 2 Signal transfer
- 2-Set isolation

With the MOSLEY Dual-Match TV Coupler "convenience" becomes a byword for the folks who have that extra TV for the den or play-room!

The Dual-Match Coupler is efficient, solderless, compact and so easily installed on baseboard or set—yet priced so low you are assured complete customer satisfaction.

Available at Radio and Television Parts Distributors, Coast-to-Coast.

MOSLEY 902 List Price **\$2.95**

Mosley Electronics, Inc.
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Si vous lisez le français
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ELECTRONIQUE INDUSTRIELLE

la grande revue française
de technique moderne
Specimen gratuit sur demande

EDITIONS RADIO

9, rue Jacob — Paris 6^e — France

Business



Merchandising and Promotion

Raytheon Manufacturing Co., Receiving and Cathode-Ray Tube Operations, Newton, Mass., launched a new promotion campaign to back up its Bonded Dealer program. The campaign includes a group of specially designed items, window display cards, streamers,



and the new Bonded Dealer Creed display. National advertising will also be used to support the program. The photo shows E. I. Montague (right), advertising and promotion manager of Raytheon's distributor tube sales staff, explaining the new material to Edward Fisher, Brookline, Mass., service technician.

Sylvania Electric Products, New York, has released a new film strip "Make Way for Color" to aid distributors and dealers in selling and servicing color TV.

Clarostat Manufacturing Co., Dover, N. H., is marketing its Fuzohm fuse-



type resistors on a wall display card which accommodates 12 units.

ORRadio Industries, Opelika, Ala., has scheduled the biggest advertising program in its history this fall and winter to promote its Irish Brand magnetic recording tape. Consumer and

HOTTEST RADIO KIT LINE TODAY!



Model GDK
List \$5.95

Deluxe MULTIPLE TRANSISTOR RADIO KIT

Finest kit of its kind today! Matched Transistors; Germanium Diode; printed circuit; Loopstick; tuning dial; 2 penlight batteries; unbreakable case. In good location operates small speaker. Simple, illustrated instructions.



Model MTK
List \$12.49

GERMANIUM DIODE LOOPSTICK RADIO KIT

Educational, fascinating, loads of fun. Complete with earphone and aerial kit. Professional metal chassis; slide rule dial; Loopstick. Only screwdriver needed for assembly. Clear, illustrated, step-by-step instructions.



TRANS- ATOMIC TRANSISTOR RADIO KIT

Model TTK List \$8.95

Another popular Superex kit. Matched Transistor and Germanium Diode; Loopstick; Slide Rule Dial; Unbreakable plastic case; 2 penlight batteries. Easy assembly with screwdriver. Simple, illustrated instructions.

Sensiphone Earphones

Deluxe Models

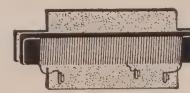
Contains features found in most expensive earphones. Powerful Alnico V magnets; balanced dual coil construction; exceptional sensitivity & tone. Featherweight.



Double Phones (2,000 ohms) List \$3.49.
Single (1,000 ohms) List \$1.98.

— NEW TRANSISTOR LOOPSTICKS —

5½" FLAT LOOPSTICK



List \$2.75

Ideal where space and performance are a consideration. Power-packed . . . high Q. Tapped for transistor use. Inductance completely adjustable.

7" FLAT LOOPSTICK
(max. power)
LIST \$3.00

TRANSISTOR VARI-LOOPSTICK



List \$1.25

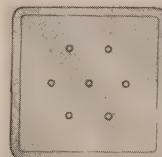
Specially designed and engineered for maximum transistor set performance. Micrometer adjustment. Extremely sensitive, compact. Has impedance tap to match transistors.

Contains full instructions including 9 suggested circuits.



4 Radford Place, Yonkers, N. Y.

Incredible American Made MINIATURE CRYSTAL MICROPHONE



We GUARANTEE IT!
Is yours for the
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A Brush Develop-
ment Product—
used, but in excel-
lent condition.
What a bargain!
for experimenters!
Perfect for ham
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this beauty! Get
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136 important circuits

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Rev. Ed.

By Matthew Mandl—\$6.50

NOW YOU CAN USE THE METHODS OF THE EXPERTS

Simple, clear explanations of the fundamentals of monochrome and color TV. Complete servicing instructions for UHF and VHF. Servicing details for the latest types of equipment: transistor, gated beam detector, color TV circuits and 100 more.

You'll learn the time-saving methods used by the experts without unnecessary theory or involved math. Illustrated every step of the way.

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SEND NOW!

STUDY ONE OR BOTH FREE FOR 10 DAYS WITHOUT OBLIGATION

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60 Fifth Avenue, New York 11, N. Y.

Please send me:

- HANDBOOK OF BASIC CIRCUITS \$7.50**
- MANDL'S TELEVISION SERVICING \$6.50**

I will either remit the full price or return the book(s) in 10 days. (Save: enclose check or money order now and we pay delivery charge.)

Name.....

Address.....

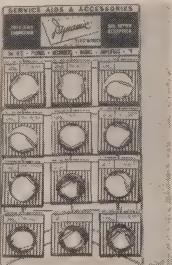
City..... Zone..... State.....

Distributors in Canada: BRETT-MACMILLAN LTD., 25 Hollinger Road, Toronto 16

BUSINESS

trade publications and, for the first time, FM radio, will be used. The campaign will feature F. R. O'Sheen, the Irish leprechaun used as a trademark.

Dynamics - Electronics - New York, Forest Hills, N. Y., is merchandising its complete line of 60 service aids, accessories, components, etc., on a self-service counter or wall rack on which



any 12 of these items may be displayed.

Rockbar Corp., Mamaroneck, N. Y., is pushing an advertising campaign to sell its English-made Collaro record changers to the mass market as opposed to concentrating on the hi-fi field. Class consumer magazines will be used.

American Pancor, Inc., Havertown, Pa., designed a new portable, metal, partitioned repair kit for its A-MP terminals, connectors and its Champ or Super Champ hand tool for crimping, cutting, stripping, etc.

HOUSE CURRENT Anywhere

Now, while fishing, camping, business trips, anywhere you drive, you can enjoy many of the conveniences usually available only at home, shop, or office:



- Electric Shavers
- Car Polishers
- Radios—Lights
- Phonographs
- Dictation Machines
- Tape Recorders
- Hand Vacuum Cleaners
- Small Do-It-Yourself Tools
- Heating Pads

"101" USES



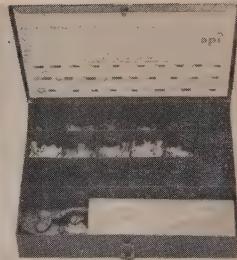
Trav-Electric CONVERTERS

No installations. Just plug into cigar lighter. That is all. Priced as low as \$11.95.



See your Electronic Parts Jobber or Dealer; or write direct to us.

TERADO COMPANY
1057 Raymond Ave. St. Paul 14, Minn.



Electro-Voice, Inc., Buchanan, Mich., is putting its promotion show "on the road." The Electro-Voice motor caravan is taking five tons of hi-fi equipment valued at \$20,000 on a nation-wide tour which will end next May in Detroit. The "road show," in addition to participating in 23 hi-fi shows, will present the Electro-Voice story to as many as 150 people at a time with a maximum turnout of a thousand per day expected.

Winegard Co., Burlington, Iowa, is under way on a large national advertising campaign to introduce its 1957 line of outdoor antennas featuring Umbrella-Ease installation. The antennas are aluminum anodized in colors. The



DēRO TV AIDS PROFITS

MORE FOR YOUR MONEY

Personna-Tone EXTENSION SPEAKER
High-quality sound for chair-side TV listening. 4x4 speaker. Solec or TV sets. Volume controls for TV sets. Personna-Tone or both speakers. Wood veneer cabinet. \$9.95 List

Dual-Tone VOLUME CONTROL

For auto radio sound extension. High volume controls one for each speaker. Volume of either speaker adjusts to any level independently. Ample cable for \$3.95 List

All Purpose DēRO JUVENATOR

One rejuvenator replaces all! Model RU-5—universal 6-wire for use on all series or parallel filament TV sets, both electrostatic and electromagnetic. Restores brilliancy and contrast to \$3.95 pix tube. List

Look for This!

Dynamic COUNTER DISPLAY
Dēro quality parts are packaged for easy identification. Look for the Dēro trademark on all television accessories.

Where Quality Counts—Buy DēRO!

AT ALL LEADING DISTRIBUTORS!

JOBBER-DEALERS! WRITE FOR DETAILS
DēRO ELECTRONICS
134 NASSAU ROAD
ROOSEVELT • LONG ISLAND • N. Y.

BUSINESS

(Continued)

color theme is carried through to the cartons which may be used for point-of-sale merchandising and promotion.

Merit Coil & Transformer Corp., Chicago, is planning a stepped-up advertising and promotion campaign for the coming year. A new 20-page catalog and 128-page All-Industry TV Repl Guide are included. Photo shows Arnold



Littleken (left), Merit sales manager, explaining the company's manufacturing facilities and techniques to Jim Cody of Cody Advertising, the company's newly appointed advertising agency, which is handling the campaign.

Federal Electronics Sales, Rockville Centre, N. Y., is merchandising its new hi-fi record-conditioning cloth treated with K-400 Kayonite antistatic chem-



ical, in a new display carton containing 12 cloths individually packed in a black-and-gold polystyrene case. END

The newest hobby under the sun!

BUILD THIS SOLAR POWERED RADIO!

and many other sun-powered electronic, electrical and photometric devices featuring International Rectifier Corporation SUN BATTERIES!

Everyone—from the beginner with a basic understanding of electrical work to the experienced professional—can build this pocket-size portable radio—powered by the sun! No batteries—not even an On-Off switch. All you need is sunshine! The basis for this radio is the International B2M Sun Battery. This unit is a scientific, accurate, precision-made photovoltaic instrument that directly converts light into electrical energy. This radio is just one of many devices you can build powered by solar energy. You have read about this new field of science, among the first in this newest hobby. Put the sun to work for you!

THIS NEW BOOK TELLS YOU ALL ABOUT SUN BATTERIES—PHOTO CELLS—and HOW TO USE THEM. Packed with information and applications, this illustrated book shows wiring, diagrams and plans—every detail necessary to build many interesting devices.

\$150



YOU'RE THE FAMOUS B2M SUN BATTERY
YOU'VE READ ABOUT. Widely used in experiments, this unit in bright sunlight (10,000 ft. candles) will deliver 2 milliamperes at 250 millivolts under optimum conditions; will last indefinitely with proper care. A \$2.50 value for only.....\$1.50

IF YOU LIKE YOUR JAZZ Hi-Fi

TAKE ALL OF THESE ALL-TIME GREAT

JAZZ CLASSICS FREE

A TREASURY OF JAZZ PERFORMANCES ENCOMPASSING EVERY ERA

Including: Charlie Parker playing Re-Education Breakdown; Sidney Bechet in Jelly Roll Blues; Art Tatum in Dark Eyes; Artie Shaw in Artie's Garland; Woody Herman in Moon Burns; Coleman Hawkins in Honeysuckle Rose; Buck Clayton in B.C. Blues, etc.

THE JAZZTONE SOCIETY, Dept. REL-11
45 West 61st St., New York 23, N.Y.

I enclose 25¢ to help cover shipping. Send me all 10 "Jazz Classics," plus "This Music Called Jazz"—mine to keep FREE, in any case. I also request a Trial Membership in my name. I am not obligated to buy any other recordings. I am to receive advance description of future monthly selections. I may try any of them without obligation. If I advance payment may reject and re-order, before or after I receive it. And I may cancel my Trial Membership at any time.

If I keep it, I will pay each 12" disc I keep—I will pay the Member's price of just \$2.98 (plus a few cents shipping charge).

LIMIT: One sample package per customer.

Name.....(PLEASE PRINT).....

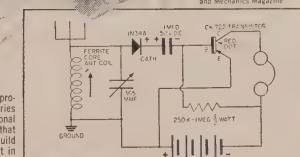
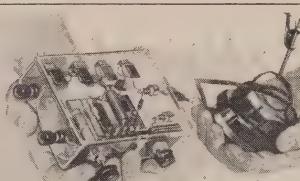
Address.....

City.....Zone, State.....
CANADA: 105 Bond Street, Toronto, 2, Ontario

Always mention you saw it in

RADIO-ELECTRONICS

When answering ads



International Rectifier Corporation
El Segundo, California

GET INTO ONE OF THESE
TOP OPPORTUNITY FIELDS

ELECTRICITY —Electronics OR TELEVISION —Radio-Color TV

TRAIN IN THE GREAT SHOPS OF

COYNE

OLDEST, BEST EQUIPPED
SCHOOL OF ITS KIND IN U.S.

Veterans and Non-Veterans—Prepare for a better job NOW that offers a real future, too! Get practical training in TELEVISION—RADIO—ELECTRICITY—ELECTRONICS—(Refrigeration & Electric Appliance Repair can be included). Learn on real equipment—no advanced education or previous experience needed. Lifetime employment service to graduates.

Finance Plan—enroll now, pay most of tuition later. Part time employment helps to students.

FREE BOOK Clip coupon for Big Free Illustrated Book. No salesman will call. Act NOW.

B. W. COOKE President COYNE ELECTRICAL SCHOOL FOUNDED 1899

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- ELECTRICITY-ELECTRONICS

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ARKAY Kits... lead the field

ANOTHER
ARKAY
FIRST!!

SPECIFICATIONS:

ELECTRICAL RATING—9 volt
BATTERY OPERATED
OPERATING FREQUENCIES
TUNING RANGE—540 to
1600 K.C.
I.F.—50
I.F. AMPLIFIER—455
K.C.
POWER OUTPUT—275 milliwatts
SPEAKER—large alnico V permanent
magnet speaker
TRANSISTOR COMPLEMENT
X1 1st I.F. amplifier
X2 1st I.F. amplifier
X3 2nd I.F. amplifier
X4 class A AGC takeoff
X4 class B driver
X5 class B output
X6 class B output



\$37.50

Federal Excise Tax Included

introducing

ARKAY Model TR-6
TRANSISTORIZED PORTABLE
SUPERHETERODYNE RECEIVER

The model TR-6 is a newly designed all transistor portable superheterodyne receiver with push-pull Class B output providing clear crisp output better than 275 milliwatts. Construction of the TR-6 is extremely simple because of the advanced engineering techniques employed in its design.



ARKAY
Model
FL-10
Hi-Fi
Amplifier

A super lin. Williamson type 12 watt Hi-Fi amplifier with built-in pre-amp. Push-pull output with a frequency response of 20-40,000 cps. 4 controls including record equalization (LP, RIAA, EUR). Output impedances, 4, 8, & 16 ohms.

\$28.95



ARKAY
Model B-8
Hi-Fi
Speaker
System

Frequency Response: 10 to 20,000 cps. Coverage Frequency: 1600 cps. Power Rating: 23 watts. Impedance 16 ohms. Features a bass reflex, ducted port enclosure. Equipped with a low frequency speaker and a compression driven horn of special design. A variable balance control w/network provides smooth and natural adjustment of the H/F speaker.

\$35.95



ARKAY
Model
FL-5
Hi-Fi
AMP.

Full 5 watt amplification for true Hi-Fi performance in average rooms. Accepts tuner or phonograph as your choice and provides unusual tone controls. Frequency response is 20-18,000 cps. at ± 1.5 db. Uses 4 miniature tubes for low hum and noise level.

Cover \$1.50 less cover \$10.75

Federal Excise Tax Included



ARKAY
Model
HFT-7
Hi-Fi
AM-FM
Tuner

Excellent sensitivity and low noise characteristic. Automatic frequency control with provision for AFC erasing allows pinpoint, high selectivity tuning. Foster-Seeley discriminator, high efficiency AM loop, VFO antenna and temperature compensated oscillator circuit.

less cover
\$32.00

Model FM-6 (FM only) \$25.75
fed. ex. tax incl.

SPECIFICATIONS:

POWER—30 watts @ 1.5% IM
FREQ. RESPONSE ± 5 db. 20-
40,000 cps
IHM—120 db. below rated output
CONTROLS—(6) Func. selector,
loudness, bass, treble, level
set, 5 position level compensation
control.

NEW
ARKAY
Model
FL-30
Hi-Fi
AMP-PRE-AMP

Featuring a transistorized front end for use with a reluctance pick-up, this engineering masterpiece assures the finest in Hi-Fi reproduction. Record equalization is more than 50 labels (LP, RIAA & EUR). Complete with rose gold panel and black cabinet.

\$49.95

Write today for full details on the remarkable units in the ARKAY line. You will receive our catalogue ABSOLUTELY FREE along with the name of your nearest dealer. Write today to Dept. RE-11.

Prices 50% Higher West of the Mississippi

ARKAY KITS, inc. • 120 Cedar Street • N.Y., N.Y.



Read Gernsback
Library Books

Servicing Record Changers. No. 59.....	\$2.90
Maintaining Hi-Fi Equipment. No. 58.....	2.90
The V.T.V.M. No. 57.....	2.50
Sweep and Marker Generators for Television and Radio. No. 55.....	2.50
Probes. No. 54.....	2.50
The Oscilloscope. No. 52.....	2.25
Transistors—Theory and Practice. No. 51.....	2.00
TV Repair Techniques. No. 50.....	1.50
Radio & TV Test Instruments. No. 49.....	1.50
Radio & TV Hints. No. 47.....	1.00
Television Techniques. No. 46.....	1.50
Radio Tube Fundamentals. No. 45.....	1.00
Basic Radio Course. No. 44.....	2.25

ON SALE AT ALL
BETTER PARTS DISTRIBUTORS

technical Literature



PARTS

The 1956 spring and summer issue of *Pocket Control Guide* (No. 4), a 96-page cross-reference guide of radio, television and audio replacement controls, is 3 1/8 x 8 1/4 inches for easy use in pocket or repair kit.

Centralab Distributors, or Centralab, Div. of Globe Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis. 20c.

RADIO-TV SERVICE AIDS

Catalog 157 offers 80 pages of radio-television service aids, among them new products such as G-C Klipzon self-holding prods and connectors, printed-circuit repair kits and phono drive kits.

Parts Distributors, or General Cement Mfg. Co. (Div. of Textron, Inc.), 919 Taylor Ave., Rockford, Ill.

TV PICTURE TUBES

A new edition of *Quick Selection Guide for Television Picture Tubes (ETD-1001C)* aids the designer in his selection of the proper tube from the large number of types on the market. 211 tubes are classified by size, bulb structure and deflection angle. Whether a tube is aluminized, external conductive coating capacitance, type of ion-trap magnet, face, style of anode terminal and dimensions are indicated.

G-E Tube Sales, 1 River Road Schenectady 5, N. Y.

SERVICE AIDS

A 1955 catalog, *ETR-589C*, of promotional and service aids to the TV and radio service dealer describes such items as business identification signs, advertising material, package promotion, business aids, service aids and technical publications.

General Electric Tube Distributors.

CAPACITOR MANUAL

The *Sprague TV Replacement Capacitor Manual K-102*, combines in a new format information previously published in separate electrolytic and ceramic manuals. It covers 6,589 TV sets made by 88 companies.

The electrolytic section alphabetically lists each manufacturer. In addition, Sprague replacement capacitors are fully described and cross-referenced to original part numbers.

The ceramic section differs in that, while it contains an alphabetical listing of sets by make, it groups Sprague replacements according to the section in the TV set in which they are used.

Sprague Distributors, or Sprague

OPPORTUNITY ADLETS

Rates—5¢ per word (including name, address and initials). Minimum ad 10 words. Cash must accompany copy. Copy must be submitted on separate paper. Discount, 10% for 12 consecutive issues. Misleading or objectionable ads not accepted. Copy for Jan. issue must reach us before Nov. 15, 1956.

RADIO-ELECTRONICS,

154 West 14 St., New York 11, N. Y.

COMPLETE YOUR HIGH SCHOOL at home in spare time with 59-year-old school. Texts furnished. No classes. Diploma. Information booklet free. AMERICAN SCHOOL, Dept. X89, Drexel at 58th, Chicago 37, Ill.

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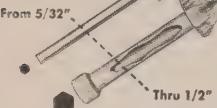
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Sangamo Electric Co., Electronics Components Div., Springfield, Ill. END

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Books



ELECTRONS, WAVES AND MESSAGES—The Art and Science of Modern Electronics, by John R. Pierce. Hanover House, Garden City, N. Y. 5½ x 8½ inches, 318 pages. \$5.

Two things about this book immediately impress the reviewer. First—and most important—the author attempts sincerely and successfully to write for the reader who is interested in electronics but has had no scientific training. Despite a few slips, the job has been done better than in any other work this reviewer has yet seen.

The second salient point is the unheard-of modernity of the book. Practically all authors of "popular" works have started out by reading earlier books on the same subject and have to some extent been trapped by their emphasis and organization. Pierce has struck out on his own trail, and sometimes finds himself 180° out of phase with earlier writers. The second chapter of the book is on the laws of motion and the sixth is titled "Maxwell's Wonderful Equations." The author—probably more familiar with traveling-wave tubes than any other types—considers these and klystrons as important as the popular book writer's time-honored triode and gives them equal or greater space. Microwaves appear more often in explana-

tions and illustration than broadcast-band frequencies.

There are places where the author may take a little too much for granted. The explanation of an oscillator circuit (page 124) is very brief for a neophyte, for example. Yet the weakest parts of this book compare very favorably with the strongest parts of almost any earlier work written with the same purpose and directed at the same audience.—FS

ULTRASONIC ENGINEERING—with PARTICULAR REFERENCE TO HIGH-POWER APPLICATIONS, by Alan E. Crawford. Butterworths Scientific Publications, London, England. Distributed in U. S. by Academic Press, New York. 344 pages. \$8.

A useful correlation of data and material on applications and effects of ultrasonic waves and on methods of applying them to load. Photographs and basic drawings of experimental and practical ultrasonic devices.

THE GENERATION OF ELECTRICITY BY WIND POWER, by E. W. Golding. Philosophical Library, 15 E. 40 St., New York 16, N. Y. 6 x 9 inches, 318 pages. \$12

The wind is a fairly common source of power for small electrical generators, especially those used to charge a 6-volt battery for radio use. In some Caribbean islands, practically every isolated home has its own wind generator for that purpose and often to supply lighting as well. They are also fairly common on our western plains.

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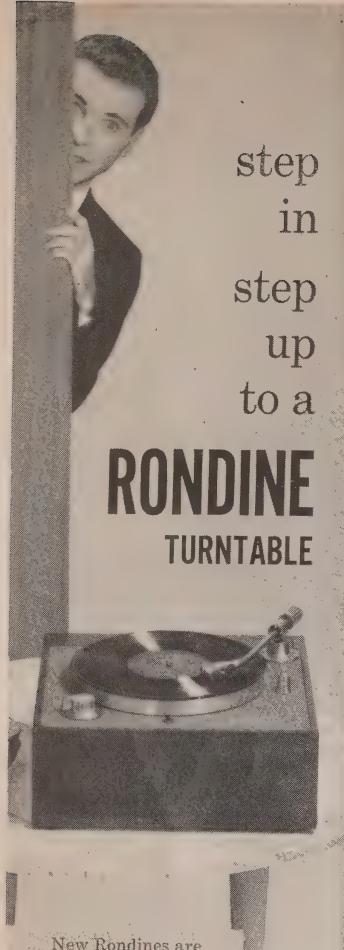
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istics, distribution, measurement and other factors pertinent to its utilization. Large wind-driven generators for power, and their utilization in combination with other power sources, are also considered.—FS

MAINTAINING HI-FI EQUIPMENT, by Joseph Marshall Gernsback Library, Inc., New York, N. Y. 5½ x 8½ inches, 223 pages. Hard cover, \$5; paper cover, \$2.90.

Hi-fi equipment requires specialized and more exacting maintenance than does ordinary audio equipment. That is the reason for this book, written by an authority in the field. This text can aid the hi-fi owner who wishes to do his own servicing as well as the professional technician. It is written in easily understood language and includes many diagrams and scope test patterns.

The book begins with a description of audio test equipment and a review of typical tone circuits, crossovers, inverters and other networks. After a chapter on preliminary diagnosis, the author continues to typical defects and how to locate them. There are three chapters on distortion alone. The reader is shown how to check for balance, ringing, clipping, parasitics and other defects. One feature is that each chapter is complete in itself and requires no cross-reference. This makes it easy to locate information on a specific problem.

As expected, the oscilloscope receives much attention as a test instrument for hi-fi equipment.—IQ

INDUSTRIAL ELECTRONICS IN QUESTIONS AND ANSWERS, by Edward J. Buckstein. Frederick Ungar Publishing Co., New York. 197 pages. \$3.95.

Prepared for students, radio service technicians and experimenters, questions and answers form an introduction to industrial electronics. Starting with resistance welding, the author progresses smoothly through photoelectricity, thyratrons, time-delay circuits, counters, scalers and test instruments. Basic diagrams and graphs are used wherever necessary.

RADIO PHILATELIA, by Herbert Rosen. Audio Master Corp., New York. 46 pages. \$2.

Prepared for experienced philatelists as well as the neophyte and layman, here's a new approach to stamp collecting. It lists over 500 stamps and several hundred postmarks and slogans dedicated to various phases of radio, TV, electronics, telegraphy and telephony. Approximately 225 stamps and 50 postmarks and slogans are illustrated in black-and-white in their original size.

MULTIVIBRATORS, edited by Dr. Alexander Schure. John F. Rider Publisher, New York. 52 pages. 90c.

This introduction to the basic principles of the multivibrator with analysis of typical free-running, one-shot (flip-flop) and bistable (flopover) types is a useful aid to understanding more advanced treatments of the subject.

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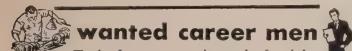
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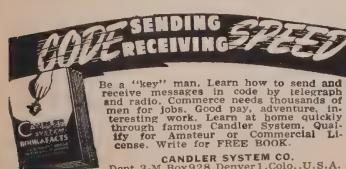
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SPECIFICATIONS

FREQUENCY RESPONSE: ± 1 db at 40,000 cps. **HUM:** 85 db below rated output. **POWER OUTPUT:** 35 watts at 4% total distortion at 1000 cps. **INPUT:** 1/4" TS, 1/4" Phone, 1/4" Phone, Crystal, Pin, Tape. **OUTPUT IMPEDANCE:** 4 ohms and 16 ohms; high impedance for tape recorder. **TUBE COMPLEMENT:** 3-12AX7, 1-12AU7, 4-EL84, 1-SU4. **FEEDBACK:** Negative feedback loops virtually eliminate distortion. **POWER:** 117V, 60 cps, 35 watts plus auxiliary power receptacles. **Dimensions:** Size: 11" x 9 3/4" D x 7 1/2" H. A combination of high power, high fidelity, gleaming beauty and advanced engineering features unmatched at twice the price. Supplied in complete kit form with simplified easy-to-follow instruction sheets. Shpg. w., 25 lbs.

KT-115—Complete kit, Net 59.50

KT-115—Complete kit,

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New high frequency tweeter featuring a louvred acoustic lens for uniform sound dispersion and capable of handling up to 25 watts of distortion-free power. The directional tendency of high frequency notes is overcome by the natural wide dispersion angle of the short horn and the acoustic lens which disperses and radiates the high notes smoothly throughout the entire listening area. Lens is designed to be mounted directly with a separate base for the tweeter desired for external mounting where desired. Aluminum voice coil has 16 ohm impedance. Size: 4 1/4" long x 3" diameter, lens extends 2 1/2". Requires a crossover network, preferably one with level control, such as the LN-2, with full instructions. Shpg. wt., 5 lbs.

HW-7 Net 14.95



2 WAY SPEAKER SYSTEM 40-16,000 CYCLES

This 2-way speaker system is another excellent buy for the moderate purse. It is basically the same as the SY-85 system described at the top of the page, but incorporates the deluxe SK-68 speaker with 21.5 oz. Alnico V magnet. This results in more efficient reproduction and extension of the lower register. Complete system includes the SK-68 12" 25 watt woofer, HK-3 cone type tweeter and LN-2 crossover network with lever-brilliance control. Range of system 35-16,000 cycles. Shpg. wt., 18 lbs.

SY-87—Complete System, Net 27.50

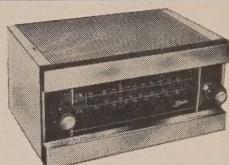
SY-86—Complete System, same as above except the HW-7 Tweeter with acoustical lens is supplied instead of HK-3. Shpg. wt., 20 lbs. Net 36.50

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The excellence of its design and the quality of its components combine to provide this compact high-fidelity FM-AM tuner with remarkable accuracy and selectivity. Costs coming several times as much, and with performance unbelievable at this low price. Features Armstrong FM circuit with limiter and Foster-Seeley discriminator. Simplified tuning with slide-rule dial and flywheel counterweighted mechanism. AFC defect circuit combined with tuning control. Attractive etched copper-plated and lacquered finish.

SPECIFICATIONS

FREQUENCY RANGE: FM, 88-108 MC; AM, 530-1650 KC. **ANTENNA INPUT:** FM, 300 ohms; AM, Ferrite loopstick and high impedance external antenna. **CONTROLS:** 2-function control for AM, FM, PHONO, and a BAND/LEVEL/DETENT control. **TUNING:** Manual, from 88 to 108 MC or 530 to 1650 KC. **FREQUENCY RESPONSE:** FM, 20 to 20,000 cps; AM, 3-3 db to 5000 cps. **AM, Loop sensitivity:** 80 uv/meter. **SELECTIVITY:** FM, 5 kc for 30 db quieting; 375 kc FM discriminator band. **AM, Loop bandwidth:** 5 kc for 30 db quieting. **IMAGE REJECTION:** FM, 50 db. **NOISE LEVEL:** 40 db. **FM, 100% MODULATION:** 100% mod. **TUBE COMPLEMENT:** 2-12AT7, 1-6GR8, 1-B86E, 2-6AU6, 1-6AL5 plus 1-6X4 rectifier. **SIZE:** 5 1/4" high x 9 3/4" wide x 9 1/2" deep (excluding knobs). **CONSUMPTION:** 30 watts. **POWER:** 110-120V 60 cycles AC. **LESS METAL CASE:** Shpg. wt., 9 lbs. **LT-10—Completely wired—** Less metal case. **Net 52.50**

ML-100—Metal cage for above, shpg. wt., 3 lbs. **Net 5.00**

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High quality cone type high frequency tweeter having a range from 2000 to 16,000 cycles. Especially efficient at higher end of audio spectrum where other cone type tweeters tend to lose their efficiency. Comes in a metal case with a base so that it can stand by itself or be mounted on a flat surface with mounting bracket supplied. Rated to handle 20 watts of power. A crossover network is included. Same as the Lafayette LN-2. **Net 5.95**

LN-3



CROSSOVER NETWORK • **WITH CROSSOVER AT 4000 CPS**
NET 8.75

The frequencies above 2000 cycles are channeled to the tweeter through the means of the capacitive-inductive network comprising this efficient crossover network. The highs and lows are brought into acoustic balance by means of a continuously variable level-brilliance control. Comes in a metal case for remote mounting. Network matches 8-16 ohm speakers with insertion loss reduced to a minimum. 2 1/2" D. With full instructions. Shpg. wt., 5 lbs. **Net 8.75**

LN-2

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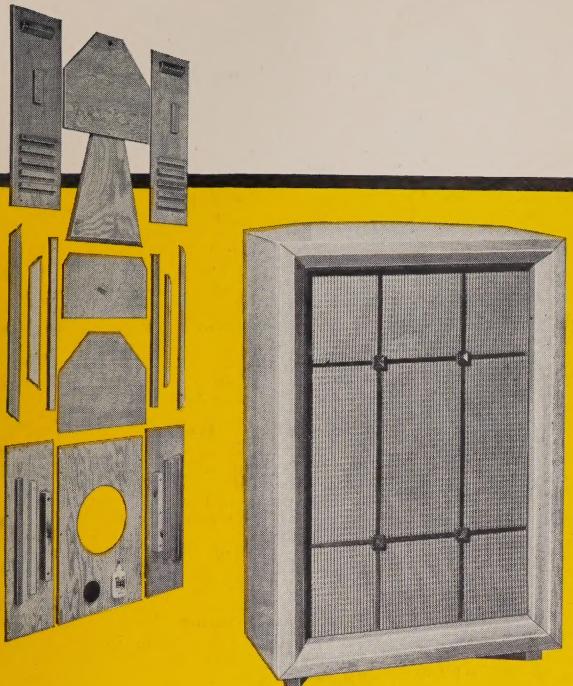
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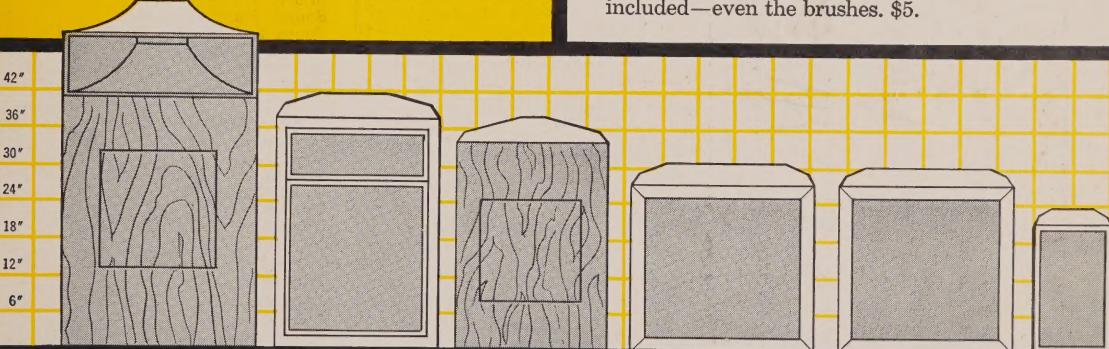
ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.	
Aero Products Co.	143
Alliance Manufacturing Co.	7
Allied Radio Corp.	9, 95-100, 137
Almo Radio Co.	151
Amphenol Electronics Corp.	80
Arkay Radio Kits Inc.	150
Atlas Sound Corp.	142
Audel Publishers	144
B & K Manufacturing Co.	106
Barry Electronics	158
Bell Telephone Labs.	26, 128
Benco Television Associates, Ltd.	92
Bendix Radio	137
Brooks Radio & Television Corp.	119
Burstein Applebee Co.	139
CBS-Hytron	22
Capitol Radio	
Engineering Institute	109-110
Central Tire & Salvage Co.	133
Chicago Standard	
Transformer Co.	124, 133, 139
Clarostat Manufacturing Co.	23
Cleveland Institute of Radio Electronics	11
Coloradaptor	133
Columbia Wire & Supply Co.	128
Cornell Dubilier Electric Corp.	21, 131
Coyne Electrical School	125, 137, 149
Delco Div. of General Motors	113
DeRo Electronics	148
Devry Technical Institute	5, 24
Dressner	135
Du Mont (Allen B.) Labs	Inside Front Cover
Dynar Co.	144
Dynamic Electronics	114
Editions Radio	146
Electro-Voice, Inc.	Inside Back Cover
Electronic Instrument Co. (EICO)	31-32
Electronic Measurements Corp.	120
Electronic Publishing Co., Inc.	126
Erie Resistor Corp.	140
E-Z Hook Test Products	135
E-Z Way Towers, Inc.	143
Futuramic	134
Garfield (Oliver) Co.	132
General Industries Co.	10
Grommes	116
Hallcrafters Co.	136
Hawkins (P. E.) Co.	133
Heath Co.	64-77
Hershel Radio	139
Hickok Electrical Instrument Co.	108
Hughes Research & Development Labs.	121
Indiana Technical College	135
Instructograph Co.	131
International Business Machines	127
International Rectifier Corp.	149
Jackson Electrical Instrument Co.	145
Jazztone Society	149
Jensen Industries	144
Kedman Co.	139
Kuhn Electronics Products	152
LMB	138
Lafayette Radio	156, 157
Lektron Specialties	141
Macmillan Co.	148
Mallory (P. R.) & Co.	82-83
McGraw-Hill Book Co.	130
Merit Coil & Transformer Corp.	24
Metropolitan Electronics & Instrument Co.	122
Mosley Electronics	146
Moss Electronics Distribution	84-87
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Musical Masterpiece Society	149
National Radio Institute	19-20
National Schools	3
Newark Electric Co.	151
North American Phillips Co., Inc.	105
Opportunity Adlets	151
Perma-Power Co.	140
Permo Inc.	153
Phaistro Instrument & Electronic Co.	117
Pickering & Co., Inc.	6
Pilot Radio Corp.	153
Precise Development Corp.	16
Precision Apparatus Co., Inc.	111
Precision Electronics	116
Prentice-Hall, Inc.	152
Progressive Edu-Kits Inc.	115
Quality Electronics	138
Quam-Nichols	112
Quietrole Co.	143
R-Columbia Products Co.	130
R & D Electronic Labs.	118
Radiart Corp.	21
RCA Institutes, Inc.	27
RCA Service Co.	30
RCA Tube Div.	Back Cover
Radio-Television Training Association	29
Raytheon Manufacturing Co.	13
Rek-O-Kut Co.	154
Remington Rand Univac	28
Rider (John F.) Inc.	25
Rinehart Books Inc.	90, 140, 146
Rockbar Corp.	151
Rohn Manufacturing Co.	17
Sams, (Howard W.) & Co., Inc.	15, 132
Sangamo Electric Co.	93
Schober Organ Co.	152
Scott (Hermon Hosmer)	14
Service Instrument Co.	135
Shure Brothers, Inc.	145
Sound Mart Unlimited	138
South River Metal Products Co.	138
Sprague Products Co.	94, 106, 112
Stan-Burns Radio & Electronics	142
Superelex Electronics	147
Supreme Publications	123
Swedgal (Moe)	147
Techmaster Corp.	12
Technical Appliance Corp.	79
Terado Co.	148
Triad Transformer Corp.	116
Trio Manufacturing Co.	91
Tung-Sol Electric Co.	8
Turner Co.	136
University Loudspeakers	18, 81
Utah Radio Products Co.	129
Vaco Products Co.	152
Volpar	131
Weller Electric Corp.	107
Western Radio	139
Western Electrical Instrument Corp.	141
Winograd Co.	94
SCHOOL DIRECTORY PAGE 154-155	
American College of Engineering	
Baltimore Technical Institute	
Candler System Co.	
Grantham School	
Indiana Technical College	
Indianapolis Electronic School	
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